農業研究

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抗葉及穗頸稻熱病遺傳之再研究[1]

稻之遺傳因子分析之第六報

張德梅　謝順景[2]

一、緒　言

稻熱病抵抗性之育種爲當前品種改良重要目標之一，在執行此工作之前應先明瞭有關抗病遺傳因子之種類，數目及其相互間之關係等。Sasaki (1922) 最初研究此問題，並認爲稻熱病抵抗性是一種遺傳性狀可照孟德爾之定律分離，而抗病性是受一對顯性遺傳因子所支配。以後有 Nakatomi (1926—1936)、Nakatomi and Kosato (1949)、Hashioka (1950) 等氏之研究，此等學者均認爲稻熱病之抵抗性受兩對顯性遺傳因子所支配。Oka and lin (1957) 用統計遺傳法分析結果，認爲稻熱病之抵抗性受一對隱性遺傳因子所控制。Takahashi (1951)、Okada and Maeda (1956) 及 Abumiya (1959) 各氏實行幼苗人工接種研究結果，認爲抗稻熱病遺傳因子至少有三對，而抗病性爲顯性，且各遺傳因子有累積效果。謝(1965) 曾在自然發病狀態下研究葉稻熱病及穗頸稻熱病之抵抗性遺傳，結果認爲支配葉稻熱病之遺傳因子有二對，除此之外有第三對遺傳因子對穗頸稻熱病之抵抗性有關。爲進一步檢討此結果，筆者等在1961～1962年之間在臺中東勢地區再度進行同樣試驗，所得結果與第五報所報告者相同。

二、材料與方法

利用本省栽培較普通的蓬萊種 7 種、在來種 9 種、日本種 4 種、大陸種 2 種、遺傳因子標識稻16種、及突變稻 7 種，作爲雜交親本。玆將此等品種之名稱、系統號及來源等示於第 1 表。

第 1 表　試驗材料之名稱來源等

Table 1. List of materials used

系統 Strains	系統名稱 Strain name	來源及分類型 Origin and type of Classification	系統 Strains	系統名稱 Strain name	來源及分類型 Orgin and type of classification
P123	臺中65號	蓬萊種（日本型）	T215	烏粒	在來種（印度型）
P124	臺中155號	〃	T229	白殼	〃
P125	臺中153號	〃	T233	高雄大粒清油	〃
P138	臺中糯46號	〃	T237	鵝卵求	〃
P141	嘉南2號	〃	T247	紅糯	〃
P163	農育糯8號	〃	J302	中村	日本種（日本型）
P167	稗稈稻	〃	J310	輪生稻	〃
T201	白米粉	在來種（印度型）	J311	初錦	〃
T203	蟻公包	〃	J313	玉錦	〃
T208	烏殼清油	〃	M503	小南秈	大陸種（印度型）
T213	柳頭仔	〃	M506	崑山五香梗	〃（日本型）

(1)本研究承農復會之補助 (62-A-1377) 得以完成，謹此誌謝，在研究進行期間又承臺中農業改良場林課長克明及林技士寶鑫之多方協助，試驗工作得以順利完成。

(2)臺灣省農業試驗所技佐及技正

D-8-9	突　變　稻	來自嘉南8號	7111		Jodon's gene marker
D-27-9	〃	來自高雄27號	7154		〃
D-65-1	〃	來自臺中65號	7156		〃
D-65-2	〃	〃	7157		〃
F-155-5	〃	來自臺中155號	7163		〃
D-155-8	〃	〃	7164		〃
M-155-6	〃	〃	7172		〃
A-32		Nagao's gene marker	7223		〃
H-25		〃	7245		〃
H-58		〃	7247		〃
7101		Jodon's gene marker	7248		〃
7107		〃			〃

將雜交 F_1、F_2 及親本同時種植於臺中縣東勢鎮，部分材料則栽培於桃園縣觀音鄉，任其自然發病。爲促使病之發生除施用重肥（250kg/公頃）外，實行密植栽培，田間常注意排水，並儘量保持乾燥狀態。在試驗田之四圍及每一雜交組合之中間種植三行染病最多的品種五香梗藉此傳播病菌之胞子。各親本種植20—50株，F_1種 2 株，F_2則種植200～300株左右，視種子之多寡而定。

發病程度之調查，根據已制定之葉病面積率圖，決定病斑面積率然後換算爲罹病指數。在成熟期調查，穗頸稻熱病之發病情形，並以罹病百分率表示罹病之程度。

部分幼苗在臺北本所玻璃室內以噴撒法接種，並以病斑型爲調查之基準（謝等1961），另外將部分材料以葉鞘接種法接種，在顯微鏡下觀察菌絲伸長之程度以定感病之程度。

三、試　驗　結　果

1. 葉稻熱病之變異及其抵抗性之遺傳：

如前所述葉稻熱病抵抗性之變異，以染病指數表示之，其與其病斑面積率之關係示如下：

病斑面積率%	0	0.2	0.5	1	2	5	11	25	55	80	100	120
罹　病　指　數	0	1	2	3	4	5	6	7	8	8.5	8.8	9

指數 0 爲無病斑，表示極抗病者，指數1～3爲病斑面積率在 1 %以下，罹病後不久卽恢復正常，而對生長無影響，可引爲抗病者。指數4～6屬於中等感病者，7～9爲重感病者，罹病株均易枯死。玆將 F_2 及其親本抗葉稻熱病之變異情形示於第二表。

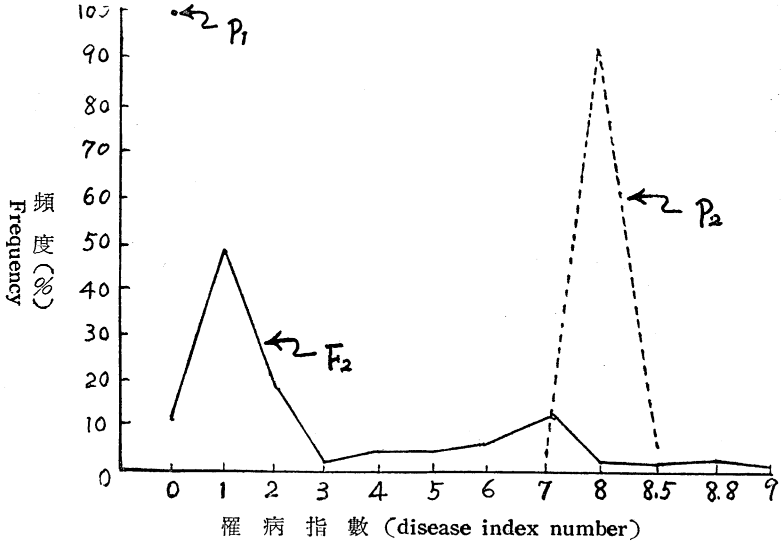
第2表　葉稻熱病之抵抗性在F_2之分離比

Table 2. Segregation for leaf blast resistance in F_2

親本及什交組合 Parents and crosses	罹病指數 Diseased index number												總數 Total	分離比 Segr. ratio	P
	0	1	2	3	4	5	6	7	8	8.5	8.8	9			
P123					1	5	19	27	7				59		
P123×P167		62	59	24	13	10	6	1	1				176	3:1	0.02-0.05
		(145)			(31)										
P167	45	15											60		
P167×7101	172	46	12	4	1								235	1:0	

7101	14	16	19	11								60		
P124						33	24					59		
P124×T208	105	34	6	6	11	9	5	1	2					
	(145)				(34)							179	3:1	0.05–0.10
T208	60											60		
P138							16	25	11	4		56		
P138×7248	83	31	10	2	2	5	10	10	8					
	(126)				(35)							161	3:1	0.3–0.5
7248	43	13										56		
T237		60										60		
T237×J310	70	30	6	4	8	8	7		1	1				
	(110)				(25)							135	3:1	0.05–0.10
J310					41	13	4					58		
D-65-2								2	55	3		60		
D-65-2×7245	115	50	12	1			6	11	14	8				
	(178)						(39)					217	[illegible]:1	0.01–0.02
7245	20	30	10									60		
D-65-2×7107	30	130	49	3	11	11	30	8	4	3	4			
	(212)				(71)							283	3:1	0.3–0.5
7107	29	10	1	1								41		
H-59					7	17	22	9	4			59		
H-59×7107	11	6	7	7	1	9	5	4	1					
	(31)				(20)							51	9:7	0.5–0.7
T208	60											60		
T208×D-27-9	73	26	13	3	9	17	5	3	1					
	(115)				(35)							150	3:1	0.5–0.7
D-27-9						18	25	16				59		

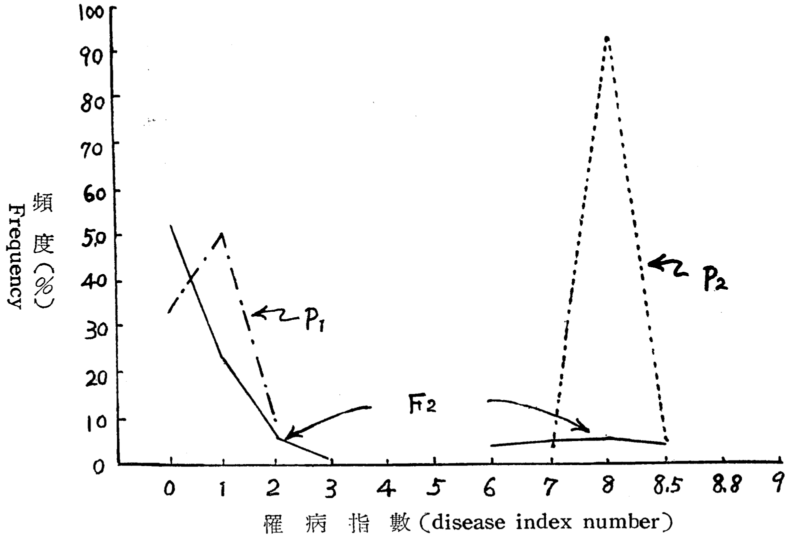
第2表所示各雜交組合與第5報（謝1965）所用之試驗材料不同，但因環境條件相同，各組合抗病性之分離情形略爲相同。P167與7101均爲抗病品種，其F_1及F_2全爲抗病，表示兩者帶有相同



P_1……7107

P_2……D—65—2×7107

P_2……D—65—2



P_1······7245
P_2······D—65—2×7245
P_2······D—65—2

第1圖　葉稻熱病發生之變異

Fig. 1 Variation of degree of leaf blast infection in term of disease index number

之抗病因子，抗病×感病或感病×抗病之 F_1 亦爲抗病，F_2則分爲抗病與感病之二羣，呈不連續之双峯變異（第1圖），此種 F_2 集團在双峯之谷作分羣之界限。P123×P167之 F_2 集團略呈連續變異不易劃分，在此情形比較双親感病變異之幅度以作分界之依據。P123×P167，P124×T208，P138×7248，T237×T310，D-65-2×7245，D-65-2×7107及T208×D-27-9 各組合，F_2 抗病與感病呈3:1之比率，抗病爲顯性，表示抗病性受單一因子所控制，但在 H-59×7107 則呈9:7之比率表示有關抗病之遺傳因子，至少有兩對。

2. 穗頸稻熱病之變異及共抵抗性遺傳：

稻抽穗後穗頸部位呈褐色潮濕狀態，白色胞子繼而產生，稻穗由頸部彎曲下垂，光合物質之轉運工作即受阻碍，因而成爲白穗，輕時產量受影響重時全無收成，實爲不能忽視之病害。因雜種後代抽穗期有早晚之分，因此不免有逃病 (disease escaping) 之現象。因此一般而言，在自然狀態下作穗頸稻熱病發生之正確調查頗爲不易。爲儘量避免此種困難曾就抽穗期較整齊的雜交組合調查，其結果示如第3表。

第3表　抗穗頸稻熱病在F_2之分離比

Table 3. Segregation for neck blast resistance in F2

Parents and crosses	% of diseased ear										Total	Segr.ratio	P
	10	20	30	40	50	60	70	80	90	100			
P123					2	7	3	2			16		
P123×T215	34	7	10	13	18	11	11	11	5	15	135	27:37	0.2–0.3
	(64)				(71)								
T215	23	1	1	1							26		
P124						5	3	8	2	38	56		
P124×T213	60	20	10	10	6	8	6	9	3	9	141	3:1	0.95–0.98
	(106)					(35)							

T213	28	8	3								93		
T210×J302	6	17	21	18	7	9	9	10	6				
	(69)					(34)					103	9:7	0.02-0.05
J302						3	7	12	8	1	31		
M506						2	3	13	4	14	36		
M506×T213	30	8	12	10	8	11	12	13	4	23			
	(68)					(64)					132	9:7	0.2-0.3
T213	28	8	3								39		
7107						2	5	2	3	5	17		
7107×D-65-2	4	14	20	20	24	16	14	9	7	16			
	(82)					(62)					144	9:7	0.8-0.9
D-155-8		7	3	5	5	4					24		
D-155-8×7154	20	1	3	5	8	3	11	15	17	23			
	(40)						(66)				106	27:37	0.3-0.5
7154	5	1		21	2	2					31		
T208×M-155-6	44	9	19	17	11	12	11	4	3	3			
	(100)					(33)					133	3:1	0.95-0.98
D-155-6	25	11	10	4							50		
T208×D-27-9	28	35	8	2	4	4	2	7	6	7			
	(77)					(26)					103	3:1	0.95-0.98
D-27-9						2	5	8	9	2	26		

由第3表可知，親本之罹病情形較集中於抗病或感病之一邊，但 F_2之變異較大，分佈於10～100之間，呈連續變異之情形較多，不如葉稻熱病有明確之分界點。因此抗病及不抗病係根據各親本感病之幅度 (rang) 來分羣。一般來說，以染病率 50 %與 60% 之間爲分界線之情形較多，低於50%者爲抗病，高於60%者爲感病，但P123×T215、J302×T234及D-155-8×7154 之三組合不在其範圍內。根據上述之標準分組所得抗病及感病之分離比有 3:1 (P124×T215，T208×M-155-6，及T208×D-27-9)、9:7(T213×J302，7107×D-65-2)及27:37(P123×T215，D-155-8×7154) 之三種，表示抗穗頸稻熱病之遺傳因子至少有 3 對。此結果與第五報（謝1965）所作結果相同。

3. 葉稻熱病與穗頸稻熱病之關係：

葉稻熱病與穗頸稻熱病目前在臺灣同樣重要，育種者常經驗到某些品種對葉及穗頸稻熱病同樣抗病或同樣感病，但某些品種對兩者之抗病情形完全相反，兩者之關係究竟如何爲育種者最關心的問題。爲明瞭此點，筆者等曾利用部分資料計算兩者之相關關係，玆將其結果示於第4及第5表。

第4表　葉及穗頸稻熱病抵抗性之相關

Table 4 Correlations between leaf and neck blasts

a) J 311

		Percentage of infected number of panicles									Total
		20	30	40	50	60	70	80	90	100	
Percentage of infected leaf area.	1										
	2										
	5			1	1						2
	11		2	3	3		4	1			13
	25		2	2	6	5	11	2	1	2	31
	55		1		2	2		1			6

80								1		1
100										
Total		5	6	12	7	15	4	2	2	53

r=0.2265

b) J311xT203 (F2)

		Percentage of infected number of panicles										Total
		10	20	30	40	50	60	70	80	90	100	
Percentage of infected leaf area	0	3	3	3	1							10
	0.2	6	15	10	5	6	2	1	1			46
	0.5	8	1	4	4	2	1	1				21
	1	3	8	6	1	2	1					21
	2	8	10	3	2	2	2	1	2		1	31
	5	23	17	14	14	3	2	2	2		1	77
	11	13	9	7	4	4	1	2				40
	25	1	1	2	3	2		1			1	11
	55		1								1	2
	80			1								1
	100											
	Total	65	65	50	34	22	9	8	5		4	271

r=0.5153**

第5表　葉及穗頸稻熱病抵抗性間之相關係數

Table 5. Correlation between leaf and neck blast resistances

系統 Strains	相關係數 Correlation coeficient (r)	雜交組合 Crosses	相關係數 Correlation coeficient (r)
P123	0.083	P123×7164	0.143
P125	0.391	P123×H-25	0.209
P167	-0.027	P123×D-65-1	0.306
J311	0.456	P123×M503	0.259
D-8-9	0.725	P123×T233	0.199
7245	0.288	P138×T215	0.475
7157	0.305	P138×7247	0.001
		J311×T203	0.852
		J313×T203	0.077
		D-65-1×D-65-2	0.344
		M506×T213	0.103
		T229×7111	0.522
		T229×7172	0.399
		D-155-5×7156	0.137

如第4表所示，就蓬萊種 J 311 而言，葉稻熱病與穗頸稻熱病之間有正相關關係。 J 311 與

T203 之雜交 F_2，二者間之相關係數爲 r=0.515，此值相當高，表示兩部位之抗病性之關係非常密切。又如第5表所示，在本研究範圍內除 P167 表示微弱之負相關關係外，其他各品系與各雜交組合均表示正相關關係。謝 (1965) 在同樣情形下試驗並計算兩者間之表現型相關 (Phenotypic correla tion) 及遺傳相關 (Genetic correlation)。結果，表現型相關有顯著與不顯著之別，但其遺傳相關大部分爲顯著，因此認爲表現型相關大小之變異係由於環境影響所致。第5表所示相關係數大小之變異可能亦由於環境影響所致。

4. 抗病遺傳因子與其他遺傳因子間之連鎖關係：

爲明瞭抗病遺傳因子與其他遺傳因子之間有無連鎖關係，乃進行卡方檢定 (Chi-squre test)，其結果示於第6表。

第6表 抗葉稻熱病遺傳因子與支配其他性狀之遺傳因子間之獨立性檢定

Table 6. Test of independence for genes of leaf blast disease resistance and other characters

雜交組合 Crosses	遺傳因子對 Gene pair (Aa Bb)	聯合性狀 Combined characters AB	Ab	aB	ab	總計 Total	X^2	備考 Note
P123×P167	Pi/pi-Lg/lg	122	56	59	7	244	11.0171	Field experiment
P123×P167	Pi/pi-Lg/lg	85	27	20	6	138	0.013	Glass house exp.
P123×7237	Pi/pi-A/a	52	37	17	9	115	0.406	Field experiment
P123×7237	Pi/pi-Lh/lh	59	24	18	7	108	0.005	Field experiment
P123×7237	Pi/pi-An/an	34	54	15	11	104	1.252	Field experiment
P124×P167	Pi/pi-Lg/lg	71	31	22	1	125	6.6861	Field experiment
P141×P167	Pi/pi-Lg/lg	87	28	21	7	143	0.010	Glass house exp.
P167×D-155-8	Lg/lg-D/d_{32}	168	56	73	2	299	17.8159	Field experiment
P167×D-155-8	Pi/pi-D/d_{32}	75	9	22	10	116	5.1920	Field experiment
P163×7245	Pi/pi-C/c	52	29	27	10	118	0.79	by leaf-sheath
P163×7245	Pi/pi-D/d	57	27	23	11	118	0.02	inoculation
P163×7245	Pi/pi-Wx/wx	59	30	11	8	108	0.47	method.
A-32×7111	Pi/pi-A/a	22	27	32	26	107	1.09	〃
A-32×7111	Pi/pi-Ur/ur	41	42	13	10	106	0.37	〃

由第6表及第7表可知，在自然發病情形下，抗病遺傳因子 *Pi* 與無葉舌因子 *lg* 之間有連鎖關係。其交換值在 P123×P167 爲31.3%，在 P124×P167爲21.5%。利用同樣雜交組合在玻璃室內作人工接種時，兩者間並無連鎖關係發現，二試驗結果不同之原因如何不太明瞭。可能由二者之溫度與環境條件及調查方法之不同所致。關於此點尙有重複試驗查究之必要。

第7表 抗葉稻熱病遺傳因子與無葉舌遺傳因子間之連鎖關係

Table 7. Linkages between genes of blast resistance and liguleléssness

連鎖之遺傳因子 Linked genes	雜交組合 Crosses	聯合性狀 Combined character AB	Ab	aB	ab	總數 Total	交換值 Recombination value (%)	P
Pi-lg (3:1) (3:1)	P123×P167	122 (127.97)	56 (55.63)	59 (55.63)	7 (5.97)	244	31.3±4.00	0.9~0.95
Pi-lg (3:1) (3:1)	P124×P167	71 (63.93)	31 (29.81)	22 (29.81)	1 (2.84)	125	21.5±5.00	0.3~0.5
lg-d_{32} (3:1) (3:1)	P167×D-155-8	168 (152.34)	56 (71.9)	73 (71.9)	2 (2.84)	299	19.4±3.33	0.1~0.2

Oka and Lin (1957) 及 Abumiya (1959) 報告謂，石炭酸反應因子 *Ph* 與 *Pi* 之間有連鎖關係，而已知*Ph*與 *lg* 之間亦有連鎖關係 (Nagao and Takahashi 1961)，因此 *lg* 與 *Pi* 之間亦應有連鎖關係。

又自第 6 表及第 7 表可知，無葉舌因子 *lg* 與 D-155-8 所帶之矮性因子 d_{32}* 有連鎖關係，其交換值爲 19.4%，上述之 *Pi*，*lg*，*Ph*，及 d_{32} 均位於 Nagao and Takahashi 氏 (1961) 的第二連鎖羣。

又自第 6 表可知，抗稻熱病之遺傳因子與花青素着色遺傳因子*C* 及 *A*，光穎因子 *lh*，芒因子 *An*，糯性因子 *wx* 枝梗彎曲因子 *Ur* 之間並無連鎖關係。

四、討　　論

1959年以前各學者所作抗稻熱病之遺傳研究，大部分在自然環境發病狀態下進行，由於不考慮病菌之生理小種，所用方法，調查標準及材料遺傳背景之不同，所得結果頗爲不一致。此等試驗結果表示在大部分之情形下，抗病性受顯性遺傳因子所控制 (Sasaki 1922，Nakatomi 1926，Nakamori 1936，Hashioka 1950，Okada and Maeda 1956，Hsieh 1961，1965)，但亦有抗病性爲隱性 (Oka and Lin 1957) 之情形。過去的研究認爲抗病性遺傳因子之數目有 1 至 2 對，(Nakamori 1926，Hashioka 1950，Hsieh 1961等)，但 Takahashi (1951) 及 Okada and Maeda (1956) 則認爲抗病性受三對遺傳因子支配，而此三對遺傳因子有累積作用 (accumulative effect) 而抗病之程度隨顯性遺傳因子數目之增加而加强。本研究結果認爲葉稻熱病之抵抗性受二對遺傳因子所控制。

東勢本試驗地稻熱病病菌已認明至少有三種以上之生理小種（簡與林1962），此等生理小種之存在，可能增加感病性之變異，並在無形中擾亂了分離比。本試驗中所指二或三對遺傳因子究竟支配抵抗何種生理小種一事不明。若一個遺傳因子控制一個生理小種之假說 (One gene for one race theory) 對稻熱病亦可說明，則在各種生理小種混雜之同一地區，理論上有二對或三對，甚至多於三對遺傳因子出現之可能性，究竟如何將爲最有興趣的研究課題。關於此點 (Goto 1959，1961) 利用不同生理小種研究結果，認爲抗稻熱病由於 4 對遺傳因子所支配，而 Narita and Iwata (1959) 的結果，需 9 對抗病因子才能說明。

關於穗頸稻熱病，因爲雜交集團抽穗期之變異性大，眞正的抗病性與逃病 (disease escaping) 有時不易區別。對穗頸稻熱病到目前爲止，尙無可靠的檢定方法爲試驗上最大困難，因此葉及穗頸稻熱病二者抵抗性之關係如何，至今尙未有明確通盤的結論。Hashioka (1950) 認爲葉及穗頸稻熱病之抗性受不同遺傳因子所控制根據 Subramanian (1957)，葉及穗頸稻熱病抵抗性有相關關係。Rangaswami and Subramanian (1958) 謂在非常感病之品種中，葉及穗頸稻熱病之間有正相關關係，而穗頸稻熱病發生之程度隨葉稻熱病之增加而增加。Ou (1961) 在泰國試驗認爲兩者之間有正相關關係。謝 (1965) 在自然發病狀態下作試驗，亦認爲兩者之間有正相關關係，而相關之程度因親本及雜交組合而不同。除去環境影響外所計算的遺傳相關均甚高，故認爲兩者之間受同樣的遺傳因子所控制，且假定穗頸稻熱病除葉稻熱病抵抗因子 Pi_1 Pi_2 外，另外有一對 Pi_3，支配其抵抗性，本研究結果似可作同樣解釋。支配葉稻熱病及穗頸稻熱病抵抗性遺傳因子間之眞正關係如何，尙需在控制環境下，對二部位作有效的人工接種，並作進一步的研究才能明瞭。

五、摘　　要

利用蓬萊、在來及突變稻等44品種爲親本作雜交，獲32個雜交組合，將其 F_1 F_2及其双親，同時種植於臺中縣東勢，在自然環境下任其發病。葉稻熱病之發生程度，根據葉病斑面積率，然後換

* d_{32} 之原來因子符號爲 d_9（謝，1962）後經國際稻米研究所之建議已改爲 d_{32}

算爲罹病指數，穗頸稻熱病之發生程度以罹病百分率表示之。

部分材料在臺北本所玻璃室內用噴撒法將胞子接種於幼苗上，並調查其病斑，另一試驗採用葉鞘接種法接種，並在顯微鏡下觀察細胞內之菌絲伸長度，以定感病之程度。

試驗結果，抗病×抗病之 F_1 及 F_2 均爲抗病，抗病×感病或感病×抗病之 F_1 爲抗病，表示抗病性爲顯性，在 F_2 抗病及感病，則分離爲3:1或9:7，表示抗病性至少受二對之遺傳因子所支配。穗頸稻熱病之抵抗性在 F_2 抗病與感病之分離比有3:1，9:7，27:37等三種，表示穗頸稻熱病之遺傳因子至少有三對。筆者等認爲第1及第2抗病遺傳因子 Pi_1 Pi_2 支配葉稻熱病，而另外加上第3因子 Pi_3 支配穗頸稻熱病之抗性。求葉稻熱病與穗頸稻熱病抵抗性之相關結果，在本研究之範圍內大部分之情形下兩者之間有正相關關係。在自然發病狀態下抗病因子 *Pi* 與無葉舌因子*lg*有連鎖關係，但在玻璃室人工接種之狀態下則無此種連鎖關係發現，不同生理小種及不同環境，可能爲其結果不同之原因。本研究中 *Pi* 與花青素着色因子 *C* 及 *A* 光穎因子 *lh*, 芒因子 *An* 糯性因子 *wx*, 穗枝彎曲因子 *Ur* 之間無連鎖關係發現。

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FURTHER STUDIES ON THE INHERITANCE OF RESISTANCE TO LEAF AND NECK BLAST DISEASES IN RICE
— GENIC ANALYSIS IN RICE VI —

By

T. M. CHANG AND S. C. HSIEH

SUMMARY

F_2 plants of 32 crosses together with their parents were planted in the field under the condition of natural infestion at Tunshu, Taichung Prefecture. Percentage of diseased leaf area was examined to determine the degree of disease infection. For artificially inoculated seedlings under the green house condition, disease lesion types were observed.

The F_2s of crosses between two resistant strains were all resistant while those of between resistant and susceptible showed 3:1 and 9:7 ratios. This indicates that at least two genes are responsible for leaf blast resistance. For neck blast resistance, in the cross between resistant and susceptible strains 3:1, 9:7 and 27:37 ratios were found showing that three genes are concerned.

Positive correlation between leaf and neck blast resistances was found. It was assumed that genes Pi_1 and Pi_2 might control neck blast as well and the third gene Pi_3 might work as a modifier.

Linkage between *Pi* and liguleless gene *lg* was found when the experiment was conducted under the natural infection condition; but no such linkage relation was recognized when the materials were artificially inoculated under the controlled glass-house condition. The course of such difference might be due to the different environmental conditions as well as different physiological races of blast fungus involved at that time.

Further, no linkage was found between genes of *Pi* and *C, A, lh, An* as well as *wx*.

水稻數量性狀遺傳之研究

王　茂　康

不同型間之雜交

一、研究目的

本省蓬萊稻（稉型）育種，過去多爲日本品種近緣雜交而來，斯以其變異範圍祇限於一定程度，近來本省省各試驗場所均以大穗、多粒之國外引進秈稻與本省稉稻作遠緣雜交，則可以使蓬萊稻增加新基，因我尋新希望，但其數種數量性狀之遺傳力及其各種相關，回歸關係加以研究，獲得瞭解，使水稻育種工作有更顯明之目標，對水稻育種必有極大的稗益。

二、研究材料及方法

㈠**研究材料**：利用本分所原有之雜交後代 F_2，計有三組合，1. 稉×稉（嘉農242×關東55），2. 秈×稉（Dular×嘉農242），3.秈×秈（Binicol×Cl9384）以及三組合之親本計有稉三個，秈三個合計六個親本（P_1-P_6）並詳細調查各單株之各種數量性狀。

㈡**研究方法**：

1. **研究性狀**：研究性狀係以與經濟價值有密切相關及兩親本差異較大的諸性狀，卽產量，株高，穗數，穗重等，然後以其所測定之結果資料，作遺傳變異率（Heritability）及表型與遺傳相關之分析。

2. **調查方法**：

產　量………………秤每株之乾谷量

株　高………………自地面至穗頂之高度

穗　數………………每單株之穗數

穗　重………………每穗之重量

穗　長………………每穗之長度

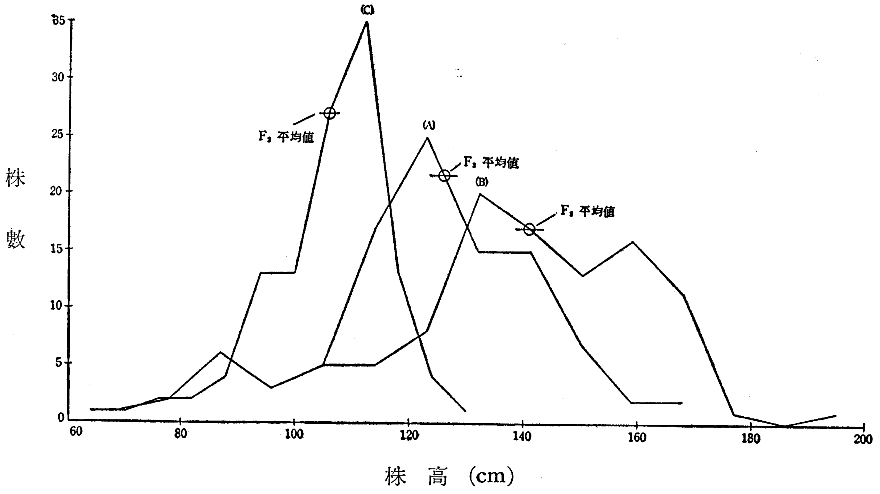
三、試驗設計

採用逢機區集法，共設四區集，每區集內含九試區，卽三雜交組合各種一試區，六個親本（P_1-P_6）各種一試區，採用單行區，行長４公尺，行距25公分，株距20公分單本植，試驗田兩邊另設保護行，試區兩端各設保護株，以免受邊際生長競爭之影響。

四、試驗結果

㈠**水稻各種數量性狀 F_2 之頻度分佈情形**

今將三個雜交組合 F_2 之株高分佈及親本株高平均和變域列於圖一；

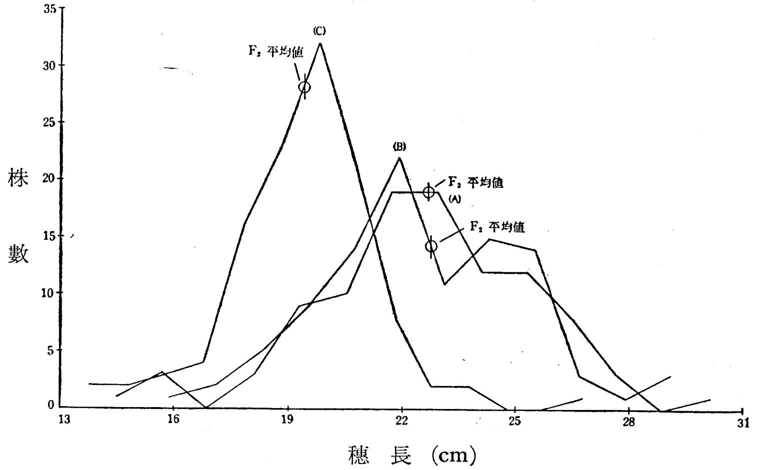


Dular×嘉農242——(A)			Binico×CI9384——(B)			嘉農242×關東55——(C)		
	平均	變域		平均	變域		平均	變域
Dular	122	91-138	Binico	140	76-159	嘉農242	112	86-161
嘉農242	112	86-161	CI9384	109	68-142	關東55	103	61-121

圖一、 三個雜交組合 F_2 之株高分佈及双親株高平均和變域；

由圖可知，在 Dular×嘉農 242 及 Binicol×CI9384 兩個雜交組合中，雜交第二代分離後之株高，有超過雙親原有範圍，F_2 之株高平均比双親者爲高，而嘉農 242×關東55雜交組合中，F_2 之株高變異範圍，趨於低的一向，F_2 株高之平均值介於双親中間。

三個雜交組合 F_2 之穗長分佈及親本穗長平均和變域列於圖二

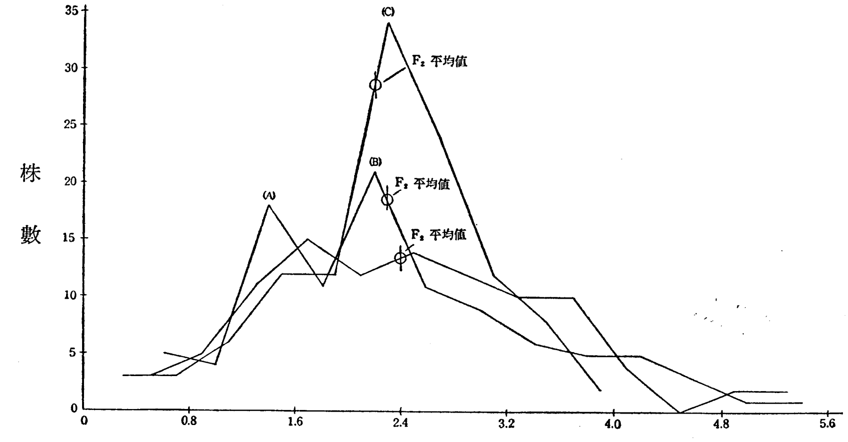


Dular×嘉農242——(A)			Binico×CI9384——(B)			嘉農242×關東55——(C)		
	平均	變域		平均	變域		平均	變域
Dular	21.5	14.9-26.2	Binico	22.7	13.7-26.3	嘉農242	21.2	16.1-25.0
嘉農242	21.2	16.1-25.0	CI9384	20.1	12.8-24.8	關東55	18.8	13.3-21.9

圖二、 三個雜交組合 F_2 之穗長分佈及親本穗長平均和變域；

由圖二知，Dular×嘉農242雜交組合 F_2 穗長之分佈有超過双親之範圍，F_2 平均穗長比双親平均穗長爲大，而 Binicol×CI9384 組合，F_2 穗長分佈爲趨於大的一向。嘉農 242×關東 55 F_2 穗長變異情形比較小，F_2 穗長平均介於双親之間。

三個雜交組合 F_2 穗重分佈與双親穗重平均及變域列於圖三



穗 重 (g)

Dular×嘉農242——(A)

	平均	變域
Dular	2.3	0.8-3.4
嘉農242	2.8	0.7-4.8

Binico×CI9384——(B)

	平均	變域
Binico	3.6	0.3-5.9
CI9384	1.6	0.6-3.9

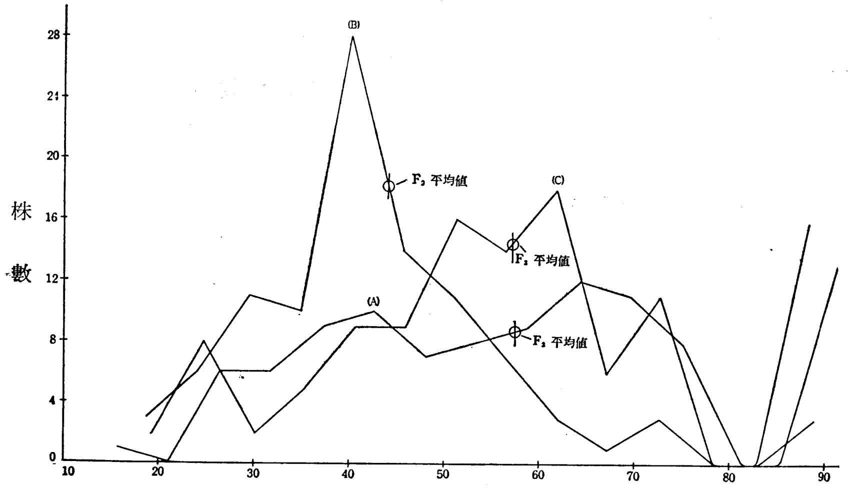
嘉農242×關東55——(C)

	平均	變域
嘉農242	2.8	0.7-4.8
關東55	1.9	0.2-3.0

圖三、 三個雜交組合 F_2 穗重分佈與双親穗重平均及變域；

由圖三知，Eular×嘉農242及 Binicol×Cl9384 兩個雜交組合 F_2 穗重分佈之變異範圍較大，在 Dular×嘉農242組合中 F_2 穗重有超過双親範圍，嘉農 242×關東55 組合 F_2 穗重分佈趨於低的一向。

三個雜交組合 F_2 穗數之分佈與双親穗數平均及變域列於圖四；



穗 數

Dular×嘉農242——(A)

	平均	變域
Dular	61.69	18.44-90.00
嘉農242	15.26	25.10-90.00

Binico×CI9384——(B)

	平均	變域
Binico	55.92	30.00-90.00
CI9384	52.65	18.44-90.00

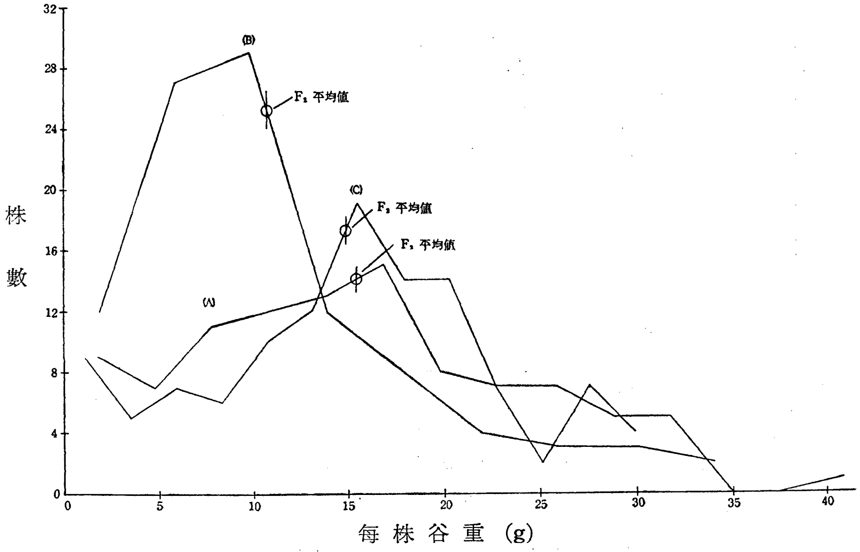
嘉農242×關東55——(C)

	平均	變域
嘉農242	55.26	25.10-90.00
關東55	57.24	18.44-90.00

圖四，三個雜交組合 F_2 穗數之分佈與双親穗數平均及變域；

由圖四可知，三個雜交組合中 F_2 穗數之變異範圍一般均較大，在 Dular×嘉農242及嘉農242×關東55組合，F_2 之穗數平均比双親為大，而在 Binicol×C19384組合中，F_2 之穗數平均比双親爲小。

三個雜交組合 F_2 每株谷重分佈與双親每親每株谷重平均及變域列於圖五；



Dular×嘉農241——(A)	平均	變域	Binico×CI9384——(B)	平均	變域	嘉農241×關東55——(C)	平均	變叫
Dular	16.3	1.2–32.9	Binico	20.2	0.7–53.3	嘉農242	18.3	1.3–33.7
嘉農242	18.3	1.3–33.7	CI9384	9.5	1.2–35.5	關東55	13.4	0.2–27.0

圖五， 三個雜交組合 F_2 每株谷重分佈與双親每株谷重平均及變域；

由圖五知，Dular×嘉農242組合，F_2 每株谷重變異範圍比較大。其 F_2 每株谷重佈有超過双親者，F_2 每株谷重平均介於双親之間，Binicol×D19384及嘉農 242×關東55 兩個雜交組合，F_2 每株谷重分佈均無超過双親範圍。

綜觀上圖所得結果可知，不同型間雜交（稉×秈），株高，穗長，穗重及每株谷重 F_2 分佈有超過双親之範圍，同型間雜交 F_2 分佈超過双親範圍者比較少。

㈡水稻各種數量性狀相關之分析

相關之分析，係爲測定兩性狀間之相互關係，一般所謂相關，即有遺傳上的關係和沒有遺傳上之關係，有遺傳之關係稱爲遺傳相關 (Genotypic Corveloticm)，沒有遺傳之關係稱爲環境關係 (Enrironment Correlaticn)，由遺傳相關和環境相間綜合所表現之相關稱爲表型相關 (Phenvtypic Cortelatlua)。各種相關係數估算公式如下；

$$表型相關\quad (r_P) = \frac{\text{Cov}\times y\,F_2}{\sqrt{\sigma_2{}_{\times F}\cdot\sigma_2{}_{\times F_2}}}$$

$$遺傳相關\quad (r_G) = \frac{\text{Cov}\times y\,F_2 - \text{Cov}\times P}{\sqrt{\left(\sigma_2{}_{\times F_2}-\sigma_2{}_{\times P}\right)\left(\sigma_2{}_{yF_2}-\sigma_2{}_{yp}\right)}}$$

$$環境相關\quad (r_E) = \frac{\text{Cov}\times yp}{\sqrt{\sigma_2{}_{\times p}\cdot\sigma_2{}_{yp}}}$$

上式中 $\text{Covxy}F_2$ 爲 F_2之xy 兩性狀之共變方 (Covaricnl)，Govxyp 爲 P_1 及 P_2 親本之

xy 兩性狀共變方平均值，$\sigma^2_{xF_2}$為 F_2 之 x 性狀變方，$\sigma^2_{yF_2}$為 F_2 之 y 性狀變方，σ_{xp}為 P_1 及 P_2 之 X 性狀之變方平均值，σ_{yp}為 P_1 及 P_2 之 y 性狀之變方平均值。

今將三個水稻雜交組合之五種數量性狀分析估算之各種相關係數所得結果列於下表；

水稻數量性狀間之各種相關係數

性狀		Dular×嘉農242				Binicol×CI9384				嘉透242×關東55			
		穗長	穗重	每株谷重	穗數	穗長	穗重	每株谷重	穗數	穗長	穗重	每株谷重	穗數
株高	表型	0.6335**	0.3783**	0.4801**	0.4914**	0.4569**	0.3991**	0.2254*	-0.01774	0.6582**	0.7728**	0.6449**	0.3891**
	遺傳	0.7233	0.4128	0.6039	0.6597	0.5083	0.3373	0.04726					
	環境	0.2833**	0.3061**	0.2985**	0.3766**	0.4222**	0.4989**	0.4013**	0.3228**	0.4110**	0.5319**	0.4567**	0.3583**
穗長	表型		0.6540**	0.5398**	0.2285*		0.6171**	0.2194*	-0.1437		0.7885**	0.5012**	0.2131*
	遺傳		0.6182	0.7031	0.4975		0.5441	-0.2243					
	環境		0.7642**	0.2923**	-0.1021		0.6743**	0.4262**	0.1098		0.2737**	0.4345**	0.1284
穗重	表型			0.7621**	0.08699			0.5812**	-0.05568			0.7664**	0.3847**
	遺傳			0.8943	0.2305			0.6242					
	環境			0.5944**	-0.05833			0.5910**	0.01810			0.6249**	0.2064*
每株谷重	表型				0.5528**				0.6725**				0.8152**
	遺傳				0.4212								
	環境				0.6673**				0.5740**				0.8079**

* 顯著達 5%平準。

** 顯著達 1%平準。

由上表來看，Dular×嘉農242雜交組合中，五種數量性狀間之表型，遺傳及環境相關，除穗重與穗數之相關爲不顯著外，其餘均有顯明之正相關，且在大多數場合，以遺傳相關係數比表型相關係數爲大。Binicol×CI9384 雜交組合中，株高與穗長及穗重，穗長與穗重及每株谷重與穗長之表型，遺傳及環境相關均有極明顯之正關係，而株高與每株谷重及穗長之表型及環境相關爲顯著，但遺傳相關，前者之相關爲不明顯之正值，而後者則爲不明顯之負值，株高與穗數之表型相關爲不顯著之負值，而環境相關爲極顯著之正值，穗長與穗數及穗重與穗數之表型及環境相關均爲不顯著，而每株谷重與穗數之表型及環境相關均爲極顯著，穗數與株高，穗長，穗重及每株谷重之遺傳相關均大於 1，此因受取樣機差影響所致。嘉農 242×關東55 號雜交組合中，五種數量性狀間之表型及環境相關大部份均爲顯著或極顯著正值，但遺傳相關係數，由於取樣機差之關係均大於 1。

總而言之，在三種雜交組合中，五種數量性狀間之表型，遺傳及環境相關，大多數均爲明顯之正關係，而遺傳相關一般比表型相關係數爲大。而每株谷重與株高，穗長，穗重及穗數之表型及遺傳相關，大部份均爲極顯著之正關係。

㈢水稻各種數量性狀遺傳力之估算

遺傳力爲數量性狀之變異性傳遞於後傳之程度，用以量度數量性狀之遺傳趨勢，遺傳力大，則表示此數量性狀有高度之遺傳性，若遺傳力小，則此數量性狀之表顯，受環境之影響極大，遺傳力可分爲廣義及狹義兩種，廣義遺傳力餘以遺傳變異成分與表型總變異成分之比值，狹義之遺傳力餘以固定性遺傳變異成分與表型總變異成分之比值，本研究係以廣義遺傳力估算水稻各種數量性狀之遺傳力，其估計式爲

$$H=\frac{\sigma^2_{F_2}-\sigma^2_{E}}{\sigma^2_{F_2}}\times 100$$

式中$\sigma^2_{F_2}$爲 F_2 之某性狀之變方，σ^2_E爲 P_1 及 P_2 之某性狀變方平均值。

今將水稻三個雜交組合所測定之五種數量性狀，利用上式估算其遺傳力，玆所得結果列於下；

水稻各種數量性狀之遺傳力

性　　狀	遺	傳 力	值	%
	Dular×嘉農242	Binicol×CI 9384	嘉農242×關東55	三個雜交組合平均
株　　高	82.75	66.20	28.52	59.16
穗　　長	76.88	43.25	40.40	53.51
穗　　重	65.31	44.44	20.26	43.34
每株谷重	51.33	20.54	0.41	24.09
穗　　數	37.56	−13.21	7.26	10.54
各性狀之平均遺傳力	62.77	32.24	19.37	38.13

由上表來看，三個雜交組合中，五種性狀之遺傳力以 Dular × 嘉農 242 之遺傳力爲較高，Binicol×Cl9384 次之，而嘉農242× 關東55爲最低。在 Dular×嘉農242 雜交組合中，以株高，穗長，穗重及每株谷重之遺傳力爲較高，其分別爲 82.75，76.88，65.31 及 51 33%，而穗數之遺傳力爲較低，37.77%。各性狀之平均遺傳爲62.77%。Binicol×Cl9384雜交組合中，以株高之遺傳力爲高，66.2%。穗長及穗重次之，其分別爲 43.25及 44.44%，每株谷重之遺傳力爲20.54%，穗數之遺傳變方爲負值，其遺傳力爲不正常，此因環境變方大所致。各性狀之平均遺傳力爲 32.24%。嘉農 242×關東55 雜交組合中，五種數量性狀之遺傳力均不大，其中尤以每株谷重之遺傳力爲最低，0.41%。各性狀之平均遺傳力爲 19.37%。

在三個雜交組合中，以株高之遺傳力爲最高，其變域自 28.53—82.75 %，平均爲 59.16%，穗長之遺傳力亦較高，其變域自 40.40—76.88，平均爲53.51%，而穗重每株谷重及穗數之平均遺傳力分別爲 43.34，24.09及 10.54%。由上所得結果來看，可知，在 Dular×嘉農242雜交組合中，株高，穗長，種重及每株谷重之遺傳力爲較高，此表示在 F_2 世代中，對性狀行單株選拔，其效果比較大。在 Binicol×Cl9384 及嘉農242×關東55兩個雜交組合中，一般各性狀之遺傳力均較低，此表明在早期世代中對此性狀行選拔，比較困難。

五、摘　　要

本研究之目的爲硏討不同型水稻品種間雜交三個組合中五種數量性狀之遺傳力及其表型遺傳及環境之相關，藉此明瞭不同型水稻品種間雜交數量性狀之遺傳力及相關關係，使對水稻品種改良工作，得到裨益。

本試驗所用材料爲二個稉稻品種，嘉農 242 及關果 65，與三個秈稻品種 Dular，Binicol 及 Cl9384 作下列三個之雜交組合；

(1) Dular×嘉農242

(2) Binicol×Cl9384

(3) 嘉農242×關東55

採用逢機區集設計，重複四次，每區集內包括九個試區，單行區，行長四公尺，每行植三十株。所硏硏究性狀有每株谷產量，株高，穗數，穗重及穗長等，試驗資料係以單株爲單位進行統計分析。

水稻各種數量性狀 F_2 之分佈，不同型間雜交（稉×秈），株高，穗長，穗重及每株谷產量 F_2 之分佈有超過双親之範圍，同型間雜交，F_2 之分佈，超過双親範圍者比較少。

水稻各種數量性狀間相關，一般遺傳相關在大多數情形下，比表型相關係數為大，每株谷重與株高，穗長，穗重及穗數之表型及遺傳相關大部份均為明顯之正關係。

水稻各種數量性狀之遺傳力，在 Dular×嘉農242 雜交組合力中，株高，穗長，穗重及每株谷產量之遺傳力比較高，此表示在 F_2 世代中，對此性狀行選拔，其效果比較大，而在 Binical×Cl9384 及嘉農242×關東55兩個雜交組合中，一般各性狀之遺傳力均較低，此表明在早期世代中，對此性狀行選拔，比較困難。

註：本研究之完成得國家長期發展科學委員會之補助，統計分析部份承本所李良先生之協助，特此一併誌謝。

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STUDIES ON THE INHERITANCE OF QUANTITATIVE CHARACTERS IN RICE I. INTER-AND INTRA-CROSSES ON THE JAPONICA AND INDICA VARIETIES

By

M. K. WANG

SUMMARY

The purpose of this study was to evaluate the heritability and inter-relationship among five a ronomic characters in the F_2 generation of three rice crosses, with the hope that such information may prove useful to rice breeders.

Two Japonia type varieties, Chianung No. 242 and Kuantung 5ց, and three Indica type varieties, Dular, Binicol and CI9384, were selected as parents for this study. The following crosses were made:

(1) Dular × Chianung No. 242

(2) Binicol × CI9384

(3) Chianung No. 242 × Kuan-tung 55

Randomized block design with 4 redlications was used in this experiment. Each block consisted of 9 plots, in sigale row plot of length 4m., 30 plants were planted. Agronomic characters measured were plant height, panicle weight, panicle length, number of panicles, and grain yield per plant. The date obtained for each character were analyzed on an individual plant basis.

The F_2 range in Japonica × Indica cross indicated a probable transgressive segregation for some quantitative characters.

In general, genetypic correlations were round to be larger than phenotypic correlations in most cases. The phenotypic and genotypic correlations of grain yield with plant height, panicle weight, panicle length, and number of panicles were significant and positive.

In Japonica × Indica crose, heritability for plant height, panicle weight, panicle length, and grain yield per plant were higher indicating that individual plant selection in F_2 for these characters should be comparatively effect. The Indica × Indica and Japonica × Japonica crosses heritability for 5 quantitative characters were relatively low. These results indicated that selection for these characters in early gererations would be difficult.

EFFECTS OF PLANTING DENSITY ON YIELD COMPONENTS OF RICE

by

W. L. CHANG*

Interest in growing rice at high population density has greatly increased in recent years, and considerable emphasis is being placed on breeding rice varieties that will assure a maximum and stable yield under close spacing and heavy fertilization. Although many investigations have already been devoted to the problem of spacing, little information is available on the mutual associations of yield components at different planting densities. Preliminary evidence shows that the relationships among yield components vary with planting density and growing season (Chang, 1965). Inasmuch as grain yield is a complex character and is largely under the influence of yield components, a knowledge of interrelationships among the components of yield may be useful in selecting superior yielding genotypes adapted to high planting densities.

Usually, the grain yield of individual rice plants is reduced when the plant population is increased. However, the total grain yield per unit area may increase because the decrease in yield per plant is offset by the increase in plant numbers. Rice varieties give differential responses to planting densities (Chang, 1964) and show a highly significant variety×spacing interaction for grain yield (Tanaka *et al.*, 1964). Generally, the increase of yield by dense planting is greater in the panicle-weight type varieties than in the panicle-number type ones (Matsuo, 1965). Rice breeders will make a substantial contribution to rice production if they could succeed in developing a rice variety with a plant type adapted to the growing conditions of high planting density. An understanding of the interaction between genotype and planting density may be of some help to rice breeders in their pursuit of this objective.

The present study attempts to furnish information on the nature of associations among components of yield of rice plants grown under different planting densities.

MATERIALS AND METHODS

Chianung 242 and Chianan 8, two of the leading commercial rice varieties in Taiwan, were chosen for the experiment. The former is a low-tillering and heavy-panicled variety while the latter tends to have more and lighter panicles than the former. These two varieties were subjected to two levels of planting density, namely,

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64 and 128 hills per tsubo (3.3 m^2) The distances between rows were 24 cm for both spacings while the distances between hills within a row were 21.5 and 10.8 cm for 64 and 128 hills, respectively. Three seedlings were transplanted for each hill. The fertilizers applied on the experimental plots were 80, 40, and 40 kg per hectare for N, P_2O_5, and K_2O, respectively. The plots were 4×2.5 m in size which were equal to 10 m^2 or 1/1,000 hectare. The experiment was laid out in a randomized complete block design with three replications.

Fifteen hills from each plot were randomly selected and data on number of days from transplanting to heading, plant height, panicle length, panicle weight, grain yield per hill, number of panicles per hill, number of grains per panicle, and weight of 100 grains were taken from each individual plant hill. A variance analysis on each recorded variable and covariance analysis for each pair of variables were made based on the data of individual plant hill. Simple correlation coefficients for all possible comparisons were calculated from these variance and covariance components.

Path coefficients, as applied by Dewey and Lu (1959), were used to partition the simple correlation coefficients into direct and indirect effects of (1) number of panicles per hill, (2) number of grains per panicle, (3) 100-grain weight on (4) grain yield per hill The nature of the causal system is shown diagramatically in Fig. 1.

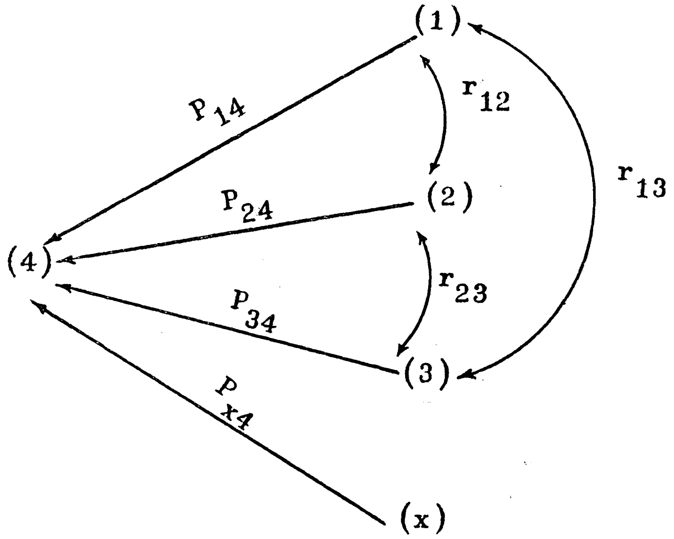

Fig. 1. Diagramatic representation of Path-coefficient analysis of the interrelationships of number of panicles per hill (1), number of grains per panicle (2), and 100-grain weight (3), with grain yield per hill (4). X represents the residual portion.

In the path diagram, the double-arrow lines indicate mutual association as measured by correlation coefficients. The single-arrow lines represent direct influence as measured by path coefficients. The residual variable (X) includes direct effects of all other factors affecting grain yield per hill in this study and is considered independent of the other 3 variables. The path coefficients in this study were

obtained by simultaneous solution through the method of least squares.

This experiment was conducted in the first crop of 1964 at Chiayi Agricultural Experiment Station.

EXPERIMEMTAL RESULTS

Effect of Planting Density on Agronomic Traits of Rice Plant

The effects of the spacing treatments upon the observed agronomic traits of the two varieties were quite remarkable (Table 1). Average yield of Chianan 8 was higher than that of Chianung 242 when both varieties were sparsely planted (64 hills per 3.3 m^2). As population density doubled (128 hills per 3.3 m^2), the grain yield per hill of Chianan 8 was reduced more rapidly (52%) than Chianung 242 (46%). Thus, at the high planting density, Chianung 242 yielded higher than Chianan 8. The average grain yield per hill of Chianung 242 was, therefore, sligh.ly higher than that of Chianan 8 when data were pooled over two spacings.

Table 1. Average values of agronomic traits of two rice varieties grown at two spacings in the first crop of 1964

Variety	Spacing (hills/ tsubo)	No. of days to heading	Plant height (cm)	Panicle length (cm)	Panicle weight (g)	Panicles per hill	Grains per panicle	100-grain weight (g)	Grain yield per hill (g)	Grain yied per ha. (kg)
Chianan 8	64	93	102	18.3	2.65	15	98	2.80	33.91	6,565
	128	91	99	16.2	1.92	9	67	2.84	16.44	6,366
Chianung 242	64	95	115	22.1	3.31	11	110	3.04	32.94	6,377
	128	94	110	20.0	2.58	7	85	3.06	17.66	6,838
Mean of 2 varieties	64	94	108	20.2	2.98	13	104	2.92	33.43	6,472
	128	92	105	18.1	2.25	8	76	2.95	17.08	6,613
Chianan 8	Mean of 2 spacing	93	100	17.2	2.30	12	83	2.82	25.18	6,466
Chianung 242	Mean of 2 spacing	94	112	21.1	2.95	9	97	3.05	25.30	6,608
Mean of 2 varieties	Mean of 2 spacing	93	106	19.1	2.62	11	90	2.94	25.24	6,537

Among the yield components, the number of panicles per hill and the number of grains per panicle of both varieties exhibited almost the same trends as grain yield per hill. There were a slight increase (1%) in 100-grain weight in the 128-hill plots for both varieties. When data were pooled over varieties, the grain yield per hill and its three components still reflected a similar response to spacings as they did in the individual treatments. Under high planting density, rice plants headed earlier, grew shorter, and bore smaller and lighter panicles. Varietal responses to spacings were similar for these four traits in both individual and pooled data.

Simple Correlations Among Components of Grain Yield

Relationships among grain yield per hill and its three yield components are

Table 2. Simple correlation coefficients among yield compoments of rice for individual and grouped data obtained in the first crop of 1964

Variety	Spacing (hills/ tsubo)	N	Correlation coefficients***					
			r_{12}	r_{13}	r_{14}	r_{23}	r_{24}	r_{34}
Chianan 8	64	45	0.0787	−0.1744	0.7733**	−0.1044	0.3007*	−0.2534
	128	45	−0.2165	−0.1803	0.6467**	0.2176	0.3770**	0.2004
Chianung 242	64	45	−0.1042	0.1529	0.5078**	−0.0365	0.3586*	0.2070
	128	45	−0.1930	−0.3232*	0.8643**	0.1141	0.1940	−0.3040
Mean of 2 varieties	64	90	−0.0283	−0.1149	0.6812**	−0.0489	0.2912**	−0.1068
	128	90	−0.3127**	−0.2527*	0.7137**	0.0824	0.2817**	−0.0202
Chianan 8	Mean of 2 spacings	90	0.0487	−0.1317	0.7596**	0.2091*	0.3629**	0.0312
Chianung 242	Mean of 2 spacings	90	−0.2230*	−0.2046*	0.7220**	−0.0030	0.1687	−0.2366*
Mean of 2 varieties	Mean of 2 spacings	180	−0.0918	−0.1313	0.7324**	0.2347*	0.2601**	−0.0048

* Significant at the 5% level.
** Significant at the 1% level.
*** X_1=panicles/hill, X_2=grains/panicle, X_3=100-grain weight, X_4=grain yield/hill.

shown by simple correlation coefficients in Table 2. Number of panicles per hill was positively correlated with grain yield per hill. The correlation coefficients were significant at the 1% level in both spacings and also in pooled data of the two varieties. The association between panicle number and grain yield was closer in the sparse planting of Chianan 8, whereas, the situation was reversed in Chianung 242. Number of panicles per hill was more closely associated with grain yield per hill in Chianan 8 and in dense planting when the data were pooled over two spacings and varieties. Generally, number of panicles per hill was negatively associated with both number of grains per panicle and 100-grain weight, especially in the dense planting of Chianung 242, where the correlations reached a significant level.

Number of grains per panicle was positively correlated with grain yield per hill in all combinations of the data. The correlation coefficients were significant except those of dense planting with Chianung 242 and its pooled data of two spacings. However, the magnitude of these correlation coefficients was much smaller than that between panicle number and grain yield. The number of grains per panicle showed a slightly closer association with grain yield when plants of Chianan 8 were closely spaced, but the reverse was true with Chianung 242. The correlation coefficient of Chianan 8 was more than twice that of Chianung 242 when data of varieties were pooled over spacings, while sparse planting gave only slightly higher correlation coefficient than that of dense planting when data were pooled over varieties. On the whole, sparse planting gave negative correlations between grain number and 100-grain weight, while dense planting the positive ones. However, the correlations were mostly of small magnitude to be of any significance.

Chianan 8 gave negative correlation between 100-grain weight and grain yield

in sparse planting and a positive one when population density was doubled. In Chianung 242 the associations were completely reversed. Four of the five grouped data except that of Chianan 8 showed negative correlations which were not significant except that of the pooled data of Chianung 242.

Path Coefficient Analysis

Path coefficients included in Table 3 show that grain yield per hill is in part the sum of number of panicles per hill, number of grains per penicle, 100-grain weight and a composite variable that includes all other factors affecting grain yield per hill in this study. Table 3 illustrates that the number of panicle per hill was the most important component and the number of grains per panicle the second most important character affecting grain yield per hill. The 100-grain weight apparently had little to do with grain yield per hill. The direct effects of the unknown variable P_{x4} were quite high and they accounted for about 12 to 55% of the variation in grain yield per hill.

Table 3. Path coefficients of factors affecting grain yield per hill for various groupings of data obtained in the first crop of 1964

Variety	Spacing (hills/3.2 m^2)	Path coefficients*			
		P_{14}	P_{24}	P_{34}	P_{x4}
Chianan 8	64	0.7375	0.2322	−0.1005	0.5783
	128	0.7971	0.4983	0.2357	0.4994
Chianung 242	64	0.5298	0.4189	0.1413	0.7426
	128	0.9212	0.3774	−0.0494	0.3400
Mean of 2 varieties	64	0.6885	0.3101	−0.0125	0.6629
	128	0.9312	0.5590	0.1691	0.4258
Chianan 8	Mean of 2 spacings	0.7530	0.3127	0.0650	0.5590
Chianung 242	Mean of 2 spacings	0.7831	0.3431	−0.0754	0.5991
Mean of 2 varieties	Mean of 2 spacings	0.7648	0.3259	0.0191	0.5960

* a_1=panicles/hill, a_2=grains/panicle, a_3=100-grain weight, a_4=grain yield/hill, x=residual factor.

The relative contribution of the three variables to yield varied with variety and spacing. The number of panicles per hill was 3.2 and 1.2 times as influential on grain yield per hill as number of grains per panicle in the sparse plantings for Chianan 8 and Chianung 242, respectively. The comparative importance of the former component to the latter one on grain yield per hill, however, dropped to only 1.6 times in Chianan 8 but climbed to 2.4 times in Chianung 242 when plants were closely spaced. When data of planting densities were pooled over varieties, the number of panicles per hill was 2.2 and 1.7 times more influential than the number of grains per panicle on grain yield per hill in sparse and dense plantings, respectively. The direct effects of the residual factor were generally higher in sparse planting than in dense one.

The direct effects of four variables were almost the same in equations computed

for each variety by including both spacings as well as in that when all data were included for the analysis. The number of panicles per hill proved to be about 2.4 times as influential on grain yield as number of grains per panicle in these three comparisons.

DISCUSSION

It was noticed that Chianung 242 and Chianan 8 responded differently to changes in spacing, with Chianung 242 showing a positive response and Chianan 8 a negative one to increased population density. When computed on a per unit area basis, the grain yield of Chianung 242 increased 7% with increased population density, which was attributable to a large increase (27%) in number of panicles per unit area and an associated small decrease (23%) in the number of grains per panicle. In contrast, yield of Chianan 8 decreased 3% with increased population density. Although number of panicles per unit area increased 20%, a more drastic decline (32%) in number of grains per panicle offset it. Grain weight was only slightly affected by spacings in both varieties, hence very little change in yield accompanied increased population density. These results have some significance on the techniques of rice culture and breeding. In growing rice, an optimum spacing should be planned for a given variety at a given crop season based upon its response to changes in spacing, since each variety seems to have an optimum spacing for maximum yield production (Tanaka *et al.*, 1964). Equidistant planting has also shown promise of increasing efficiency of grain production at high population density (Chang and Yang, 1965). In varietal trials, several levels of spacing should be provided so that relative yield potentials of genotypes tested could be correctly evaluated.

Chianung 242 is generally regarded as a typical panicle-weight-type variety. It appeared therefore, that panicle-weight-type variety was more adaptable to the growing conditions of high population density. The result of this experiment was in close agreement with the finding of Takahashi (1944). He reported that the increment of yield by dense planting was greater in the panicle-weight-type varieties than in the panicle-number-type varieties. Matsuo (1965) cited an experimental result of the Hokaido Agricultural Experiment Station showing that the panicle-weight-type variety, Ishikarishiroge, increased more in yield under dense planting than did the panicle-number-type, Eiko. Tanaka (1965) also suggested that a higher yield will probably be obtained with a weak-tillering variety closely spaced.

The relationships among the three components of yield and their relative contributions to grain yield per hill changed with spacing, although they consistently displayed considerable influence upon grain yield. Among the three yield components, number of panicles per hill appeared to be the most significant variable affecting grain yield, especially at high population density. It is worthy of note that the number panicles per hill generally had stronger negative associations with the other two yield components at closer spacing. This will be a great concern to rice breeders because simultaneous improvement of these three components is made

difficult, if not entirely impossible, by the unfavorable correlations between number of panicles per hill and the other two components of yield. Since a unit of length chopped off the long edge of a rectangular parallelepiped will decrease the volume (yield) less than a unit removed from a short edge (Grafius, 1964), it seems more profitable to increase the number of grains per panicle in breeding programs designed to develop a new variety adapted to high population density. Inasmuch as number of grains per panicle was negatively correlated with the number of panicles per hill, selection for more grains is likely to exclude the possiblility of selecting a high tillering type which may be less adapted to closer spacing (Takahashi, 1944; Matsuo, 1965; Tanaka, 1965). Heritability estimate of grain number per panicle is generally high (Matsuo, 1953), therefore, selection for this character would be effective.

Rice plants compete severely for light and nutrients at closer spacing. Lowered light penetration from increased foliar shading produces more elongated internodes and thinner culms. These characters increase lodging tendency at high population density. Another difficulty which may result from dense planting is reduced spikelet fertility which arises presumably through increased shading of panicles during anthesis (Jennings and Sornchai, 1964). To avoid these pitfalls, some basic changes in architecture of the rice plant may be needed. Since most varieties adapted to dense planting are also adapted to heavy fertilization (Matsuo, 1965), a plant type of short, sturdy culms and erect, short, narrow, thick, dark-green leaves suggested by Jennings and Beachell (1965) for nitrogen responsiveness may well be the right one to seek for dense planting. By a more efficient combination of yield components, plant type and cultural methods, it is highly probable that rice culture at high population density can be greatly improved.

SUMMARY

Experimental results of two rice varieties, Chianung 242 and Chianan 8, planted at two spacing treatments in the first crop of 1964 at Chiayi Agricultural Experiment Station are reported.

Grain yield per hill decreased with increased population density, with Chianan 8 decreasing at a higher rate than Chianung 242. However, per unit area grain yield increased in Chianung 242, while that of Chianan 8 decreased at higher population density. A similar trend prevailed also in number of panicles per hill. Number of grains per panicle decreased whereas 100-grain weight increased at higher population density.

The relationships among the 3 variables changed with spacing. Number of panicles per hill was positively associated with grain yield per hill, the correlation coefficients being highly significant. The magnitude of the correlation coefficients was reduced in Chianan 8 but increased in Chianung 242 with increased population density. Number of panicles per hill showed higher negative correlations with

number of grains per panicle and 100-grain weight at high population density. Number of grains per panicle was also positively correlated with grain yield per hill. Weight of 100 grains was not significantly associated with grain yield per hill.

Examination of the direct influence of yield components on grain yield per hill indicated that the number of panicles per hill was the most important character affecting grain yield per hill, and the number of grains per panicle ranked next. Weight of 100 grains had little direct influence on grain yield per hill. Residual factor appeared to have affected about 12 to 55% of the variation in grain yield per hill.

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栽植密度對水稻產量構成因素之影響

張　萬　來

摘　要

嘉義農業試驗分所於民國53年第 1 期作舉辦栽植密度對水稻產量構成因素影響之試驗並得下列結果。

嘉農 242 號及嘉南 8 號水稻每株谷粒產量均隨栽植密度之增加而減少，尤以後者爲甚。惟嘉農 242 號水稻之單位面積谷粒產量却隨栽植密度之提高而增加， 而嘉南 8 號則減少。每株穗數亦具有類似每株谷產量之反應。每穗粒數因密植而減少，但百粒重則稍增。

每株谷粒產量及其構成因素彼此間之關係，隨栽植密度而改變，每株穗數與谷粒產量具有極顯著之正相關，嘉農 242 號之相關係數，因密植而增大，而嘉南 8 號則因密植而變小。每株穗數與每穗粒數及百粒重之間成負相關，其關係以密植處理者爲密切。每穗粒數與每株谷粒產量亦成正相關，但百粒重與每株谷粒產量之間却無顯著之相關關係。

每株穗數爲決定每株谷粒產量之 最重要因素，每穗粒數次之。 百粒重對每株 谷粒產量之直接影響甚微。剩餘因素尚能決定12至55%之產量變異。

應用 2,4-D Gibberellin 及 Tomatotone 在高溫時期誘致番茄單爲結果之研究

郭　國　柱

一、前　　言

番茄爲本省主要果菜類之蔬菜，由於其果含有多量維他命C，一般人多以生果食用。因之銷路至廣，栽培面積日趨增多；但本省氣候冬寒夏熱，對番茄生育有所不利。因番茄花粉發育及受粉最適當溫度爲25°-30°C，如低於15°C或高於32°C 卽花粉發育不良，且不結果。查其原因略分三點，(1)溫度高其養分消耗多，植物體發生營養不良，引起落花現象，(2)氣溫超過 32°C 以上番茄則易引起不能結果現象，(3)氣溫及濕度高，易罹病害，植株未長大時如罹染病害，卽呈枯萎。由上可觀本省之氣候夏季高溫多濕對栽培番茄事業實有莫大之障礙。

對誘致植物單爲結果之研究甚多。其方法略有下列幾種。

1. 以異種花粉刺戟之方法。
2. 使用小型注射器將植物生長素注射子房內之方法。
3. 使用植物生長素羊毛脂膏塗於柱頭之方法。
4. 使用植物生長素水溶液噴射或浸漬柱頭之方法。

本所園藝系過去曾在番茄普通栽培季節應用2,4-D 促進番茄單爲結果，成績甚佳，並可增加產量。

又臺灣大學黃涵先生曾在寒冷番茄不易結果時期利用 P.C.A. (para-Chtorophenoxyacetic-acid) 處理番茄，結果甚佳。

本試驗卽在夏季高溫季節，應用 2,4-D，Gibberellin 及 Tomatotone 等植物生長素，對番茄花粉發育不良，不授粉之缺點探求有效之辦法。

二、試驗材料及方法

1. 供試之番茄：使用 Manalee 品種，在50年 6 月 1 日播種，50年 6 月22日定植於玻璃室內栽培。每處理 6 株，15處理，共90株。其各種處理明細如下。

代　號 Abbreviation of treatments	處　理 Treatments
D_5	2,4-D 5 p.p.m
D_{10}	2,4-D 10 p.p.m
D_{50}	2,4-D 50 p.p.m
D_5+G	2,4-D 5 p.p,m+Gibberellin 10 p.p.m
$D_{10}+G$	2,4-D 10 p.p.m+Gibbreellin 10 p.p.m
$D_{50}+G$	2,4-D 50 p.p.m+Gibberellin 10 p.p.m
T_2	Tomatotone 2%
T_1	Tomatotone 1%
$T_{0.5}$	Tomatotone 0.5%

T_2+G	Tomatotone 2%+Gibberellin 10 p.p.m.
T_1+G	Tomatotone 1%+Gibberellin 10 p.p.m.
$T_{0.5}$+G	Tomatotone 0.5%+Gibberellin 10 p.p.m.
CK_1	對照區，不剪去柱頭先端
CK_2	對照區，剪去柱頭先端1/3

2. 每株在開花2穗時摘心做單幹整枝，每穗留3朶花，花多時摘去。
3. 除CK_1區外之每區，在開花當天，每花剪去柱頭先端，後浸漬各種藥劑水溶液約一秒鐘。
4. 使用日本石原產業株式會社出品之 Tomatotone 及日產化學工業株式會社之2,4-D，以蒸溜水調配各種濃度。
5. 使用美國 Pfizer 公司出品之 Gibberellin，調配爲 10p.p.m。

三、試 驗 結 果

1. 試驗地之環境說明：

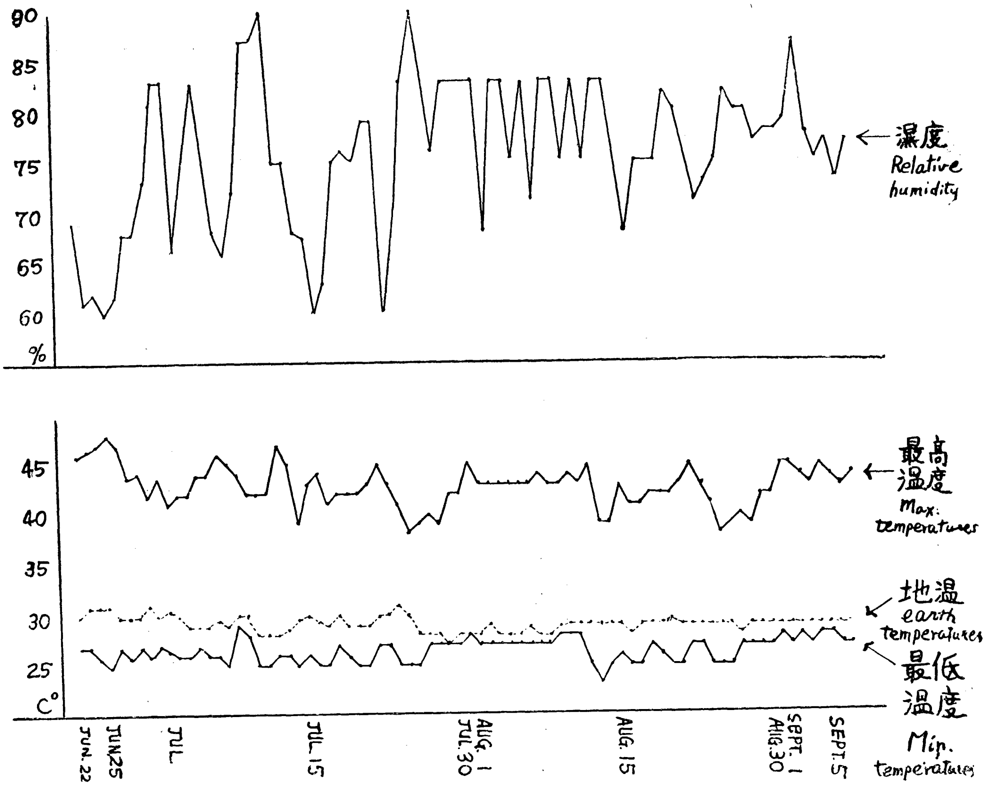
(1)試驗期間玻璃室內之氣溫，地溫及濕度如下圖。

(2)氣溫：在玻璃室內試驗期間之最高溫度爲48°C，平均最高溫度爲 42.67°C。最低溫度爲 23°C，平均最低溫度爲 26.38°C。總平均爲 34.57°C。

(3)地溫：地溫之測定僅於每日上午十時調查一次。最高爲 31°C，最低爲 27°C，平均爲 29.07°C。

(4)濕度：濕度亦於每日上午十時調查一次。最高達90%，最低爲60%，平均爲75.6%。

2. 藥品處理與着果率之關係：各處理之着果率如「表二」以T_1+G區之68.3%爲最好。D_{10}，D_{10}+G，T_1及T_2+G 區次之，均爲63.3%，CK_1 之着果率爲 0 ，CK_2 之着果率爲0.03%，G區爲



圖： 最高最低氣溫，地溫及濕度圖。

Fig: Relative humidity, Maximum and minimum air temperatures, and earth temperatures in the green house studied.

表一、着果率（每株平均）

Table 1: Effect of 2,4-D, gibberellin and tomatotone treatments on fruit-setting of tomatoes (per plant)

處理別 Treatments	處理花數 Number of treated flowers	着果數 Number of fruits-setting	着果率 Percentage of fruits-setting
D_5	6	2.5	41.7 %
D_{10}	6	3.8	63.3
D_{50}	6	1.7	28.3
D_5+G	6	2.8	46.7
D_{10}+G	6	3.8	63.3
D_{50}+G	6	2.7	45.0
T_2%	6	3.5	58.3
T_1%	6	3.8	63.3
$T_{0.5}$%	6	3.2	53.3
T_2%+G	6	3.8	63.3
T_1%+G	6	4.1	68.3
$T_{0.5}$%+G	6	3.3	55.0
G	6	0.3	0.05
CK_1	6	0	0
CK_2	6	0.2	0.03

表二、每果重量及每株產量：

Table 2: Mean weights of fruits and fruits yield per plant

處理別 Treatments	每果平均重量 Mean weight of per fruits	每株平均產量 Mean yield of per plant
D_5	11.86 g	29.65 g
D_{10}	15.34	58.29
D_{50}	11.69	19.87
D_5+G	18.20	50.96
D_{10}+G	18.80	71.44
G_{50}+G	17.80	48.06
T_2%	25.65	89.78
T_1%	26.19	99.22
$T_{0.5}$%	7.64	24.45
T_2%+G	27.38	104.04
T_1%+G	27.41	112.38
$T_{0.5}$%+G	12.88	42.50
G	4.38	1.31
CK_1	—	—
CK_2	4.00	0.80

0.05%，這三區之結果率最差。因此可知在夏季應使用 Tomatotone 1%水溶液加用 Gibberellin 始可使着果率良好。

3. 藥品處理與產量之關係：各處理之每株平均產量如「表二」。以 T_1+G 區之 112.38 公克爲最好。T_2+G區之104.04 公克次之。每果平均重量亦以 T_1+G 區之 27.41 公克爲最好。T_2+G之 27.38 公克次之。

四、討　　論

1. 本省夏天在玻璃室內栽培之番茄，不用植物生長素處理，剪去柱頭先端時即無法結果，不剪去柱頭時亦僅有 0.03%之結果率，等於無法結果。且結果後亦不長大。其最大原因乃係溫度過高，如溫度超過 32°C 時卽不易受粉，又溫度過高時植物體內之消耗很多，因此果實不易長大。

2. 使用 2,4-D在夏季促進番茄單爲結果，不論單用或加用 Gibberellin 均以 10p.p.m 區爲最好。卽 D_{10} 區之63.3 %及 D_{10}+G區之63.3%等之結果率。每株平均產量最高的爲 D_{10}+G區之71.44 公克。總言之使用 2,4-D 時應稀薄爲 10p.p.m，再加用 Gibberellin 最理想。

3. 使用 Tomatotone 在夏季促進番茄單爲結果，着果率以 T_1+G 區之 68.3% 爲最高，每株產量亦以 T_1+G 區之 112.38公克爲最高。因此如使用 Tomatotone 在夏天高溫時應使用 1%水溶液，再加用 Gibberellin 爲最理想。

4. 單用 Gibberellin 在夏季促進番茄單爲結果，其效果甚差，無利用價值。與 2,4-D 及 Tomatotone 混合使用始可得其利用價值。

5. 在夏季高溫季節促進番茄單爲結果，使用 2,4-D 及 Tomatotone 兩種植物生長素及其各種濃度之結果，以 Tomatotone 1%加用 Gibberellin 10p.p.m 之效果最好。

、摘　　要

1. 本試驗爲探求在高溫季節時如何誘致番茄單爲結果之問題，在省農試所園藝系玻璃室內進行。時間爲50年 6 月至 9 月之夏季溫度最高時期。

2. 本試驗使用 Manalee 番茄品種，在50年 6 月 1 日播種，6 月22日定植於玻璃室內栽培。每處理使用 6 株共有15處理，總共使用株數爲90株。

3. 每株開花 2 穗時摘去心芽，每穗留花 3 朵，多時摘去。在開花當天除 CK_1 區以外每花剪去柱頭先端後處理藥品。

4. 使用 2,4-D，Tomatotone 及 Gibberellin 三種藥品配製各種濃度浸漬當天番茄開花花朵約一秒鐘。

5. 在番茄生育期中玻璃室內溫度最高達 48°C，最低爲 23°C，平均爲 34.57°C。

6. 使用 Tomatotone 比 2,4-D 結果良好。如再加用 Gibberellin 更佳。

7. 使用 Tomatotone 時以 1%加用 Gibberellin 10p.p.m 最理想。

8. 使用 2,4-D 時以 10p.p.m 加用 Gibberellin 10p.p.m 最理想。

9. 生長期溫度過高影響果實之長大，每株最高產量僅爲112.38公克，每果最重僅爲 27.38 公克，故無商品價值。

参 加 文 献

1. 淺見與七博士還曆記念出版會　園藝新說
2. 萩原十，石黑喜門，篠原捨喜　蔬菜栽培綜典
3. 藤井健雄　蔬菜栽培技術
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5. 住木諭介　植物ホルモン
6. 黃永傳，譚靜吾　農業研究（第4卷第4期第86頁 2,4-D對番茄單爲結果之誘導）
7. 黃涵、洪立　臺大農學院報告，第 4 卷第 3 期70～93低溫氣節施用 Para-Chlorophenoxyacetic acid. 對番茄着果及果大之影響

THE EFFECTS OF 2,4-D, GIBBERELLIN, AND TOMATOTONE ON THE INDUCTION OF PARTHENOCARPY IN TOMATOES UNDER THE HIGH AIR TEMPERATURE CONDITIONS

By

K. C. Kou

SUMMARY

It has been known that the conditions of unfavourable air temperatures (below 15°C or over 32°C) pollen grains of tomatoes do not develop, making it difficult to produce tomato fruits in mid-winter or summer season on lowland area of Taiwan. In these cases, parthenocarpy may be induced by certain chemicals.

The author studied the effects of 2,4-D, gibberellin, and Tomatotone in a green house where the highest temperature reached 45°C using Manalee tomatoes. Although in this experiment fruits produced were not large enough, smaller ones were produced when flowers dipped in various concentrations of 2,4-D or Tomatotone. The author also found that the combination of one per cent Tomatotone and 10 ppm of gibberellin showed the best results both in fruits-setting and fruit-size.

RELATIVE ERODIBILITY OF SOILS ON HILLY LANDS IN TAIWAN*

Part I. Properties of the soils affecting soil erosion.

by

S. T. WANG and T. H. LIN

With increasing emphasis of the development of hilly lands for agricultural production in Taiwan, it has become more essential to evaluate the relative erodibility of major soils from the view point of conserving soil on cultivated lands.

Although some information about the erosional behavior of soils on sloped lands has become available through the time consuming runoff plot tests, no laboratory studies were carried out, which may reveal any relationship between erosivity and physico-chemical properties of the soils. This study was carried out to study the properties of soils affecting soil erosion and their relationship to soil erodibilities.

Studies on the mechanism of soil erosion(1) indicated that water erosion of soils is due to the dispersive action of the rain and the transporting power of surface runoff which are greatly affected by the properties or conditions of soils as well as other factors. Musgrave(2) found that amount of soils lost by surface runoff is closely related to both capacity and rate of the infiltration of soils. Middlelton(3) suggested the dispersion ratio as an index of the ease with which the particle would be brought into suspension. Bouyoucos(4) suggested that the clay ratio which is obtained from the ratio of $\frac{\text{sand}+\text{silt}}{\text{clay}}$ in the soil could be a possible criterion of judging the relative susceptibility of soil to erosion. Lutz(5) pointed out that soils with porous profiles, larger stable aggregates which result in greater permeability are much less susceptible to erosion.

EXPERIMENTAL PROCEDURES

Description of soils studied:

Six of main soils on hilly lands were selected for the study. In selecting the sites of soils to be studied, following assumptions were proposed to eliminate factors other than soil property itself and to unify the enviromental conditions.

1. Solum of the soil should be deeper than 70 cm.
2. Slope of the land surface is ranged from 15% to 25%.
3. Soils are cultivated to crops, but soils other than the surface are still undisturbed.

The general descriptions of the soils are provided as follows:

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Tsao-tun Soil (草屯)

This soil is a member of well drained Yellow Earth derived from soft, brownish yellow sandstones and shales. It extends on low hilly lands of Tai-chung and Nan-tou area. This soil is included in Dah-an (大安) series according to the "Soils of Tai-chung District."(6) Sheet erosion is prevailing usually on steep cultivated lands. Soils samples were collected from 25% sloped peanut field 4 km south east of Tsao-tun (南投縣草屯鎮圳寮坑)。

Profile description:

I. 0– 20 cm: Dark yellowish brown (10 YR 4/4, M.) friable loam, moderate medium subangular blocky structure, pH 4.6.

II. 20– 40 cm: Yellowish red (5 YR 5/6, M.) firm clay loam, moderate medium subangular blocky structure, pH 4.6.

III. 20–100 cm: Yellowish red (5 YR 5/6, M.), firm clay loam containing some weathered sand stones, weak medium angular blocky structure, pH 4.7.

Yen-chao Soil (燕巢)

This soil is a member of well drained Yellow Earth derived from rather hard reddish brown sandstones. The soil is included in Kuan-tze-lin series (關子嶺) reported in "Soils of Kao-hsiung Prefecture."(7) It is distributed over outer parts of low hilly lands of Kang-san (岡山) area. Sheet erosion is prevailing on the steep cultivated lands. Soil depth is usually less than 100 cm. Samples were collected from 15% sloped sugar cane field, 1.5 km north east of Yen-chao (高雄縣燕巢鄉大埔仔)。

Profile description:

I. 0–12 cm: Dark yellowish brown (10 YR 4/4, M.), friable sandy loam, moderate medium subangular blocky structure, pH 6.1.

II. 12–35 cm: Dark yellowish brown (10 YR 4/4, M.), firm sandy loam, weak moderate subangular blocky structure, pH 5.8.

III. 35–65 cm: Dark brown (7.5 YR 4/4, M.), very firm sandy loam, compact massive structure, pH 5.8.

Ah-kung-tien Soil (阿公店)

This soil is a member of Lithosol derived from soft grey calcareous mudstones. The soil is included in Tso-chen series (左鎮) reported in "Soils of Kao-hsiung Prefecture."(7) It is distributed on the low hilly lands of southern Taiwan ranging from Yu-chin, Tainan (臺南玉井) to Chi-san, Kao-hsiung (高雄旗山). In this area, being subjected to extremely severe erosion and land slides, a vast area of the lands has been destroyed to bad lands. Soils deeper than 70 cm are seldom found on steep lands. Soil samples were collected from 15% sloped cassaba field located at 2 km north east of Yen-chao (高雄縣燕巢鄉千秋寮)。

Profile description:

I. 0–15 cm: Olive brown (2.5 YR 4/4, M.), hard silty clay, moderate medium angular blocky structure, with excessive cracking, pH 6.1.

II. 15–30 cm. Olive (5 Y 4/3, M.), silty clay with common grey (5 Y 5/1) mottling, very sticky when wet and very hard when dry, weak medium angular blocky structure, pH 6.9.

III. 30–60 cm: Grey (5 Y 5/1, M.), very hard silty clay with common olive grey (5 Y 5/2) mottlings along ped surfaces, coarse angular blocky structure containing great portion of partly weathered mud-stones, pH 7.3.

Feng-san Soil (鳳山)

This soil is a red earth derived from old dilluvium of sand stones. It is scattered on gently sloping low hills of Feng-san (鳳山) area. This soil is much similar to the soils of Heng-chun (恒春) series reported in "Soils of Kao-hsiung Prefecture."(7) Moderate erosion is prevailing on the soils and shallow gravelly soils are frequently found on steeper lands. Soil samples were collected from 20% sloped pineapple field near the runoff test plots of Feng-san Tropical Agricultural Experiment Station (鳳山熱帶園藝試驗所)。

Profile description:

I. 0– 18 cm: Yellowish brown (10 YR 5/4. M.), soft clay loam, weak medium subangular blocky structure, pH 4.2.

II. 18– 39 cm: Dark brown (5 YR 4/4. M.), slightly firm clay loam, weak coarse subangular blocky structure, pH 4.9.

III. 39– 60 cm: Reddish brown (5 YR 4.5/4, M.), slightly firm clay loam massive structure, pH 5.1.

IV. 60–100 cm: Yellowish red (5 YR 5/7) firm clay loam with massive structure, pH 4.9.

Tai-tung Soil (臺東)

This soil is a young soil derived from soft calcareous grey shales. It is occupying the east side of low gently sloping foothills of Tai-tung coastal mountains. The soil samples were collected from 15% sloped sugar cane field near the runoff test plots of Taiwan Sugar Company's farm at Chia-lu-lan, Taitung (臺東縣加路蘭)。

Profile description:

I. 0– 14 cm: Very dark greyish brown (2.5 Y 3/2, M.), very firm clay, moderate coarse angular blocky structure with excessive cracking, pH 6.5.

II. 14– 20 cm: Very dark grey (10 YR 3/1, M.), very firm clay, rich in organic matter, very coarse angular blocky structure, pH 6.2.

III. 20– 45 cm: Olive (5 Y 5/4, M.), clay with very dark grey (10 YR 3/1) streaks, very firm massive to weak very coarse angular blocky structure, very sticky when wet, pH 7.2.

IV. 45–100 cm: Olive (5 Y 5/3, M.). clay with common yellowish brown partly weathered shale fragments. Very firm massive to weak, very coarse angular blocky structure, pH. 8.0.

Pin-chen Soil (平鎮)

This soil is a member of well drained reddish brown latosols derived from old

diluvium. The soil is grouped in Pin-chen series reported in "Soils of Tao-yuen Prefecture."[8] It occupies the higher table lands and the surrounding low hilly lands of Tao-yuen and Shin-chu area. Soil samples were collected from 15% sloped tea plant field of Pin-chen Tea Experiment Station (平鎮茶業試驗所)。

Profile description:

I. 0- 14 cm: Yellowish red (5 YR 4/4 M.), clay, friable fine granular structure, pH 4.4.

II. 14- 32 cm: Yellowish red (5 YR 4/8 M.), clay, slightly firm moderate fine subangular blocky structure, pH 4.5.

III. 32- 49 cm: Red (2.5 YR 4/5 M.), clay, firm moderate to weak medium subangular blocky structure, pH 4.6.

IV. 49-100 cm: Red (2.5 YR 4/5, M.), clay, firm massive to weak medium subangular blocky structure, pH 5.1.

Methods:

Before soil samples were taken, infiltration capacities of the soils were determined in situ under constant water head of 1 cm by double cylinder method modifying the method proposed by Musgrave.[2] The inner cylinder was driven into the soil to a depth of 25 cm which is deep enough to reach the subsoils to prevent lateral movement of water to minimum during the infiltration. Amounts of infiltrated water were recorded at the intervals of 5 minutes during the first 30 minutes and 10-15 minutes during the next succeeding period. Triplicated determination were made and the average values were adopted as results.

Soil samples collected by horizon of each soil were subjected to physical and chemical analyses. Properties included in the physical analyses were bulk density, particle density, porosity, dispersion ratio, clay ratio, aggregate stability and particle size distribution.

Chemical analyses were made to determine soil reaction, organic matter and free iron contents in the soils.

Triplicated determination of bulk density, particle density and porosity were made by the methods provided in "Agricultural Handbook No. 60 of USDA"[9], except bulk density was determined by paraffin method. The method used for determining soil dispersion ratio was that outlined by Middleton.[3] With this method, the despersion ratio is expressed in percentage of the silt and clay determined under suspension of a 20 times end over end inversion to the total silt and clay obtained by mechanical analysis. Method for aggregate stabilities of particles less than 50 microns was that proposed by Lee.[10] The value was obtained from the sum of positive difference between mechanical and aggregate analysis.

Particle size distribution was determined by the Hydrometer method.[11]

The clay ratio was obtained from the ratio $\frac{\text{sand}+\text{silt}}{\text{clay}}$ in the soil as suggested by Bouyoucos.[4]

Soil reaction was determined by glass electrode method using 1:1 soil-water ratio.

Free iron and organic matter contents were determined by $Na_2S_2O_4$-EDTA method[12] and Walkey's rapid method[13] respectively.

RESULTS AND DISCUSSION

As well recognized, field soil erosion is influenced by a great number of factors. The results shown here aim to take into account only the soil factor and to indicate to what relative degree the various soils would be susceptible to erosion under the same condition.

Infiltration capacity and rate:

Both capacities and rates of the infiltration for the soils obtained by this methed aim to show the relative ones of the soils under the same conditions rather than to show the actual ones that take place on the sloping lands. Amounts of infiltrated water should be much less than those obtained by this method because of less opportunity for water to infiltrate into soils on sloping surfaces.

Figure 1 shows the infiltration capacities of the soils determined for 2 hours at field. The amounts of water infiltrated into soil were expressed in cumulative surface centimeters against time. The result shows that highest capacity was obtained for Tai-tung soil at first 90 minutes but the total capacity remained pretty low after all. Total infiltration capacities for Feng-san and Tsao-tun soils were highest although their capacities in early period were lower than that of Tai-tung soil. The capacities of Yen-chao and Ah-kung-tien soils were always lowest through the whole infiltration period.

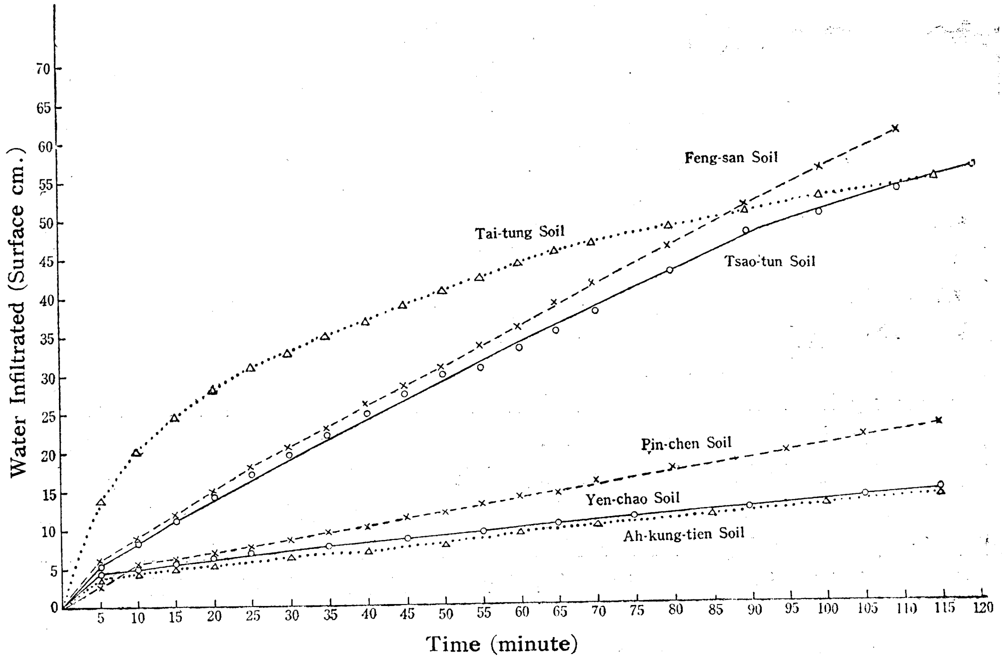

Fig. 1. Cumulative Infiltration (Surface cm.)

Figure 2 shows the infiltration rates of the soils calcultated from water infiltrated in succesive unit time. The rates are expressed in surface millimeters of water infiltrated per 10 minutes. The results show that the infiltration rates of all

soils were decreased rapidly in first 30 minutes-period and turned to the stable minimum rates in about 100 minutes. As the result shows, the minimum infiltration rate of Feng-san soil is the highest of all soils, it exceeds that of Yen-chao soil by almost 5 times. In general, the minimum infiltration rates of the soils mav be grouped into three groups.

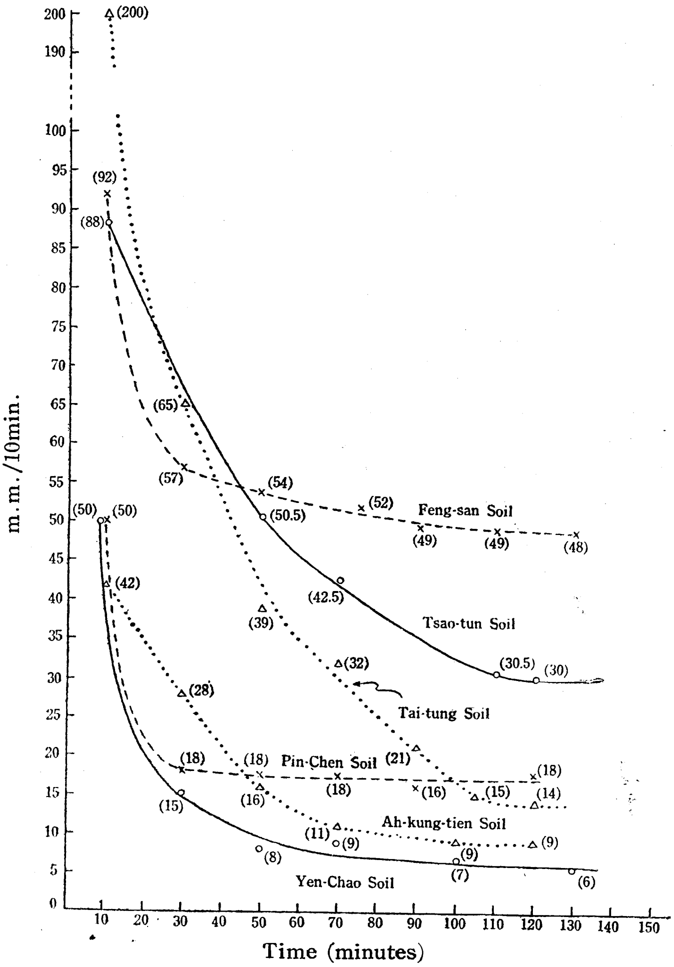

Fig. 2. Infiltration rate (Surface m.m./10 min.)

Extremely high infiltration group includes Feng-san and Tsao-tun soils which have minimum infiltration rates of more than 30 mm per 10 minutes. Pin-chen and Tai-tung soils are included in moderately high infiltration group ranging from 14 mm to 19 mm per 10 minutes. Ah-kung-tien and Yen-chao soils are included in low infiltration group having the rates of less than 10 mm per 10 minutes. The rates of minimun infiltration and their ratios for the soils are listed as follows:

Soils	Tsau-tun	Yen-chao	Ah-kung-tien	Feng-san	Tai-tung	Pin-chen
Minimum infiltration rate (mm/10 minutes)	30	6	9	48	14	18
Ratio of minimum infiltration rate	5	1	1.5	8	2.3	3

Since soil moisture and other conditions of land surfaces were not able to be controlled under the same levels at field, the minimum infiltration rates of the soils would provide more meaningful information in considering their contribution to surface runoff than the total infiltration capacities.

In refering to characteristics of the soil profiles, no evident relationship between infiltration rate and texture profile of the soils, but close relationship was found between porosity distribution of the profile. Higher infiltration rates of Tsau-tun and Feng-san soils are related to the uniform higher porosity of around 40% through the profiles and lower infiltration rates of other soils are resulted from the less porous layers of around 30% porosity in the profiles. Less porous lower subsoil of around 27% in porosity of Tai-tung soil resulted in low infiltration rate at latter period. As Baver(14) found that percolation rate, which is approximately the same as the minimum infiltration rate, increased directly with non-capillary porosity. Further study on the non-capillary porosity of the soils will reveal closer relationship between porosity and infiltration rate.

The extremely high infiltration rate (200 mm/10 minu.) of Tai-tung soil at first period is due to the consumption of infiltrated water by filling spaces of excessive cracking of surface soils, the rate was decreased rapidly after the cracking was saturated.

Dispersion Ratio and Aggregate Stability:

As shown on table 1., the dispersion ratios of the soils are all high. According to the classification proposed by Middleton(3), all of the soils studied are included in erosive group if based on this property alone.

Among the soils tested, Tsao-tun soil has the lowest dispersion ratios ranging from 20 to 30 through the profile and Feng-san soil has the highest ranging from 40 to 50. Soils of Ah-kung-tien, Yen-chao, Tai-tung and Pin-chen have the intermediated dispersion ratios ranging from 30 to 40 through the profiles.

In a soil, the dispersion ratio of different horizon is increased with the depth, with a exception of Pin-chen soil. This fact implies subsoils will be more masily eroded once they are exposed and plowed.

In considering the relationship between dispersion ratio and other single properties, contents of organic matter and clay in soils contributed to the soil's resistance to dispersion. In a given soil, content of organic matter takes more important part in increasing soil's resistance to disporsion than that of clay does. This fact was seen in the results showing that the dispersion ratios of surface soils with higher organic matter but lower clay contents are usually lower than those of subsoils with lower organic matter but higher clay contents.

Among the different soils, clay content in the soil apparently contributed to the resistance to the dispersion with exception of Fen-san soil. This implies that sandy soil is more susceptive to disperse than clayey soiL This tendency is even more apparent in aggregate stability of particles less than 50 microns in the soils, The stability was decreased with increase of clay ratio of the soil.

Contents of free iron in the soils did not affected the dispersion ratios or

Table 1. Physical and Chemical Properties of the Soils

Soils	Horison	Depth (cm)	Texture	Sand %	Silt %	Clay %	Porosity %	Clay ratio $\frac{Sand+Silt}{Clay}$	Dispersion ratio	Aggregate stability	Organic matter %	Free Iron (Fe_2O_3%)
Tsao-tun	I.	0-20	L	36.92	36.76	36.32	47.21	2.80	18.39	51.48	1.49	2.92
	II.	20-40	CL	30.92	31.76	37.32	41.51	1.68	22.58	53.48	0.86	4.80
	III.	40-100	CL	36.92	38.76	39.32	40.15	1.67	26.82	53.48	0.77	3.56
Yen-chao	I,	0-12	SL	62.34	29.16	8.50	46.30	10.76	32.82	25.30	1.45	2.86
	II.	12-35	SL	60.34	25.16	14.50	31.37	5.90	36.21	25.30	0.30	2.21
	III.	35-65	SL	60.34	31.16	18.50	40.66	4.41	41.26	23.30	0.28	0.50
Ah-Kung-tien	I.	0-15	SiC	8.00	50.00	42.00	41.04	1.38	36.96	58.00	1.48	3.08
	II.	15-30	SiC	8.00	46.00	46.00	31.50	1.17	34.78	60.00	1.07	3.23
	III.	30-60	SiC	2.00	51.00	47.00	32.73	1.13	51.02	48.00	0.95	3.78
Feng-san	I.	0-18	CL	36.22	35.00	28.78	33.96	2.47	46.69	34.00	1.02	2.65
	II,	18-39	CL	38.22	28.00	33.78	40.74	1.96	43.35	35.00	0.96	2.70
	III.	39-60	CL	38.22	27.00	34.78	41.48	1.88	59.53	35.00	0.76	2.75
	IV.	60-100	CL	39.22	27.00	33.78	38.52	1.96	52.29	29.00	0.65	2.95
Tai-tung	I,	0-14	C	10.22	37.00	52.78	36.92	0.89	24.26	68.00	2.65	3.17
	II.	14-20	C	0.22	37.00	62.78	36.57	0.59	19.82	80.00	3.51	2.81
	III.	20-45	C	9.22	32.00	58.78	27.01	0.70	35.01	59.00	1.18	2.58
	IV,	45-100	C	21.22	26.00	52.78	27.84	0.89	40.34	47.00	0.79	2.12
Pin-chen	I.	0-14	C	21.30	35.70	42.00	48.51	1.38	30.11	54.00	1.86	4.53
	II.	14-23	C	20.30	34.70	45.00	32.56	1.22	24.73	61.00	1.82	4.29
	III.	23-49	C	16.30	30.70	53.00	36.30	0.87	30.70	57.00	0.97	4.92
	IV.	49-100	C	14.30	32.70	53.00	40.11	0.87	21.70	67.00	0.91	5.03

aggregate stabilities of the soils.

CONCLUSION

Based on the capacity of reducing surface runoff and soil's resistance to dispersion, Tsao-tun soil is regarded as the most non-erosive among the soils because of its higher infiltration rate, lower dispersion ratio and higher aggregate stability. Based on its highly dispersible property, Feng-san soil is regarded to be easily eroded if it is subjected to the lasting heavy rainfall which the intencity usually exceeds the infiltration rate in rainy season.

Soils of Ah-kung-tien and Yen-chao are regarded as the easily erosive because of their higher dispersible properties and low infiltration capacities and rates.

SUMMARY

To evaluate their relative erodibility, six soils from cultivated lands on the slopes ranging from 15% to 25% were subjected to the field study on their soil profile characteristics and infiltration capacity. Analyses on their physical and chemical properties including porosity, particle size distribution, dispersion ratio, aggregate stability, clay ratio and contents of organic matter and free iron in the soils were carried out.

The results revealed that:

1) Highly porous profile of the soil resulted in higher infiltration capacity of the soil. The infiltration rates of all soils were decreased rapidly in first 30 minutes and then gradually decreased to the stable minimum values in 100 minutes. Higher infiltration rates were found for Tsao-tun (草屯) soil and Feng-san (鳳山) soil, but lower rates for Ah-kung-tien (阿公店) and Yen-chao (燕巢) soils.
2) All of the soils tested are highly dispersible according to their dispersion ratios and aggregate stabilities. Lower dispersion ratios were found for Tsao-tun (草屯), Tai-tung (臺東) and Pin-chen (平鎮) soils and higher ratios for Feng-san (鳳山) , Yen-chao (燕巢) and Ah-kung-tien (阿公店) soils.
3) According to the result of higher dispersion ratios of subsoils, it is expected that soils will be easily eroded once the subsoils are exposed and cultivated.
4) The resistance to dispersion of the soils were increased directly with the contents of organic matter and clay in the soils and no evident relationships were found for free iron content.
5) Based on the infiltration rate and dispersion ratio of the soils, Tsao-tun (草屯) soil is regarded as the least erosive and soils of Ah-kung-tien (阿公店) and Yen-chao (燕巢) as easily erosive.

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臺灣坡地主要土壤之冲蝕性研究

1. 影響土壤冲蝕之性質

王 新 傳　林 登 鴻

中 文 摘 要

爲探究丘陵地區坡地主要土壤之相對冲蝕性，選擇坡度在15～25%土壤深度70公分以上之耕地土壤，在現地作剖面性狀觀察與水分滲浸率測定，並就土層別採取土壤在室內測定與土壤冲蝕有關之各種土壤理化性質。

本試驗選擇的土壤共有六種卽 (1)平鎭洪積臺地上紅壤 (2)草屯砂頁岩風化黃壤 (3)燕巢砂岩風化黃壤 (4)阿公店泥岩風化石質土 (5)鳳山洪積層紅壤 與(6)臺東頁岩風化石質土。

室內分析項目有 (1)機械分析 (2)孔隙度 (3)分散率 (4)團粒安定度 (5)土壤反應 (6)有機質含量 與(7)粘土率。

其結果簡述如下：

1. 土壤剖面之孔隙度較高的土壤（如草屯土壤），其現地水分滲浸率較高，所有土壤之滲浸率在最初30分內均急速減低，以後卽緩慢減低，至100分時達到安定的最低滲浸率。其最低滲浸率以草屯、鳳山，土壤較高，阿公店及燕巢土壤較低，其差異多至5倍左右。
2. 土壤分散率與團粒安定度之測定結果顯示，所有土壤均頗易分散其分散率大多在20以上。草屯、臺東及平鎭等土壤之分散率較低（20～30）而鳳山、燕巢及阿公店等土壤之分散率均高（30～50）。
3. 所有土壤之底土分散率均高於表土，由此可推測現有表土流失底土露出而被開墾呈膨鬆狀態時更易引起冲蝕。
4. 土壤之有機物及粘土含量對土壤分散率及團粒安定度有直接關係。有機物與粘土含量愈高，分散率愈低，而團粒安定度卽愈高。但游離鐵含量則未發見有相關關係。
5. 由土壤分散率與水分滲浸率測定之綜合結果，因其分散率低（18～27）滲浸率高（30公糎/10分），草屯土壤被認爲最難被冲蝕。阿公店及燕巢土壤因分散率高（30～50）滲浸率低（6～9公糎/10分）被認爲最易被冲蝕之土壤。

洋菇種菌長期保存方法之研究

胡 開 仁 宋 細 福

一、緒 言

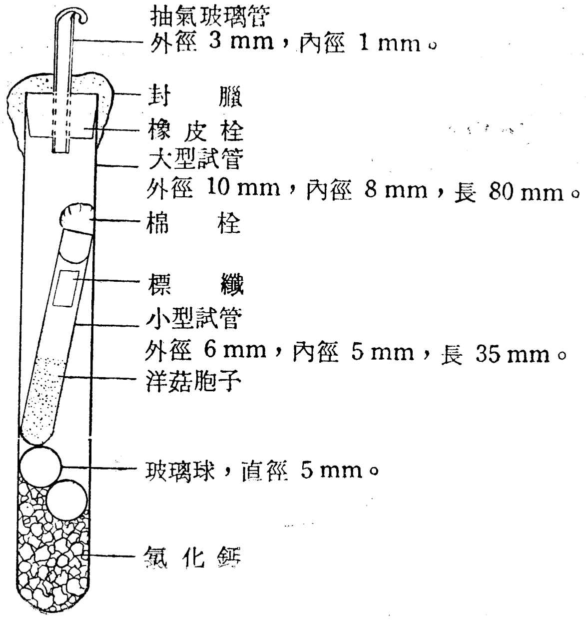
一個優良洋菇品種之育成，並非一朝一夕之功，然而一旦育成，又因沒有適當方法去保存，往往經多代之繁殖培養而形成變異或產量遞減之可能，此實為洋菇栽培上之重要問題。

最近 Rhodes (2.3), Soriano (4.5), 赤井與淺田(1)等氏以眞空乾燥方法貯存其他微生物，得到長期貯存之效果。筆者乃依據赤井等氏(1)，病原菌培養之長期保存方法；用以試驗長期貯存洋菇胞子與組織，企以長期保持洋菇品種優良之特性及減少反覆繁殖培養而產生可能之變異，是為本試驗研究最終目的。

本試驗承中國農村復興聯合委員會贊助經費，及陸技正之琳多方面之指導，又在工作進行時，蒙徐所長水泉不斷勉勵與支持，得以順利完成，謹致謝忱。

二、材料及方法

本試驗是在無菌操作下，採取洋菇 (*Agaricus campestris* L. et Fr). 胞子或組織置於殺過菌之 Sordelli 保存管（如圖一）之小型試管內，塞好棉栓。另將乾燥劑氯化鈣 0.5gm 及玻璃球兩個，置於大型試管底，再將上述之小型試管放入大型試管中，即以備妥之橡皮栓塞好，並用封臘密封管口，再以油壓幫浦 (Oil Rotary, Vacuum Pump), 眞空抽氣，使管內眞空度達 8mm/Hg. 時，用噴燈熔封上部之抽氣小玻璃管，而後分別置於 −4°, −2°, 0°, 5°, 15°, 25°C. 及室內常溫下貯存，定期取出接種於 P. D. A. 培養基上，放在 25°C 定溫箱內培養，經七天後取出調查其發育情形。



圖一、Sondelli 保存管

三、試驗成績

表一、洋菇胞子及組織眞空乾燥貯存對不同溫度之關係

Table 1. Preservation of basidiospore and tissue of *A. Campestris* by Vacuum-drying Method under Various temperatures.

處理別／發芽情形／調查時間	−4°C		−2°C		0°C		5°C		15°C		25°C		室內常溫		CK	
	T	S	T	S	T	S	T	S	T	S	T	S	T	S	T	S
三　天	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
六　天	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	−*
一個月	+	+	+	+	−	+	−	+	−	+	−	+	−	+	−	−
二個月	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	−
四個月	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	−
六個月	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	−
一　年	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	−

附註：＋：發芽　　　　*：發生雜菌
　　　－：不發芽　　　T：洋菇組織
　　　S：洋菇胞子
　　　CK：未經處理的洋菇胞子及組織置於常溫下貯存。

由上表得知，洋菇組織經眞空乾燥後放在 −2°, −4°C 定溫箱內貯存一個月尙有發芽能力，在 0°, 5°, 15°, 25°C 及常溫下貯存，僅有六天的生活能力，而未經處理者，在室內常溫下貯存六天後調查均已失去其生活能力。

洋菇胞子除不經處理，在六天後因濕度太高，發生雜菌，而失去生活能力外，其他經過處理者，不論置於上述任何溫度下，在一年內均有發芽能力，至於發芽率是否有遞減，及可能保存最長時間等問題，尙在繼續試驗研究中。

四、討　　論

以眞空乾燥的方法貯存微生物，前人已有很多的報告； Rhodes (2.3) 報告；曾以 400種之微生物，用眞空乾燥的方法貯存至13年後，其中約有88%之微生物尙有生活能力。又 Soriano (5)報告；曾以 *Salmonella, Corynbeacterium, Saccharomyces* 等菌，保存有10年的紀錄。*Rhodotorula, Aspergillus* 等菌保存有 8 年的紀錄，*Escherichia* 保存有 6 年的紀錄，*Phycomyces* 及 *Rhizopus*，等菌保存有 4 年的紀錄。最近赤井及淺田等氏，曾用 *Cohliobolus miyabeanus* No. 13, 58, 及 *Pricularia oryzae* No. 3 (Kyoto), 等菌，以 Sordelli 法保存有 6 年的記錄。

本試驗亦引用 Sordelli 法貯存洋菇胞子至 1 年間調查結果在 −4°, −2°, 0°, 5°, 15°, 25°C 及室內常溫下貯存，均有良好的生活能力，但是否能如前人之報告，像其他菌類一様，可以保存多年不致死亡，容待今後繼續調查與研究，至於所貯存之胞子，在各種處理下，因時間的延長，其胞子發芽率是否有遞減的現象，及對洋菇產量之關係如何？尙待進一步之探討。

設如本法可以保存洋菇胞子生活力至多年，且不影響其品種之優良特性，則對洋菇良種之保存，將有莫大之價值，至於洋菇組織以同樣方法貯存，因其能維持生活力之時間太短（如表一），故對於實用價值不大。

五、摘　　要

1. 洋菇胞子以 Sordelli 法眞空乾燥貯存，不論置於 −4°, −2°, 0°, 5°, 15°, 25°C，或室內之常溫下，在一年內均能保持良好的生活力，至於是否可以繼續貯存多年及對洋菇產量之關係如

何，尚待今後之調查與研究。

2. 洋菇組織以同樣方法貯存，經壹個月後，均失去其生活能力，故無繼續研討之必要。

3. 未經處理之洋菇胞子或組織，不宜於室內常溫下貯存。

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STUDY ON THE PRESERVATION OF BASIDIOSPORES AND TISSUES OF *AGARICUS CAMPESTRIS* L. ET FR.

By

K. Z. Hu and S. F. Song

SUMMARY

Comparative studies were made on the viability of basidiospores or tissue of *A. campestris* stored at -4°, -2°, 0°, 5°, 15°, 25°C and at room temperature under vacuum-drying condition. Spores stored at different temperature, except those not placed in vacuum-drying tubes, all retained germinability after one year's storage. A shorter storage period, however, was obtained with mushroom tissue. The tissue when stored at -2°, -4°C was still viable after one month, but lost its viability after one month at 0°, 5°, 15°, 25°C and at room temperature. Those tissues not stored in vacuum-drying tube retained their viability for less than one week.

臺灣柑橘之新害蟲—柑橘褐蜘蛛*

(*Eutetranychus banksi* (McGregor))

羅　　幹　　成

有關臺灣為害柑橘枝葉之蜘蛛類中，柑橘紅蜘蛛 (*Panonychus citri* (McGregor)) 及柑橘黃蜘蛛 *Eutetranychus sexmaculatus* (Riley)) 近年來已有甚多之研究報告，尤對柑橘紅蜘蛛之藥劑防治及天敵調查已有了相當詳盡之記載，而柑橘褐蜘蛛 (*Eutetranychus bankei* (McGresor)) 在臺灣之發現尚屬首次，雖其目前所造成之災害並不嚴重，但仍有提早研究防範之必要。

一、學名之變更

1. *Tetranychus banksi.* McGregor 1914, 2. *Neotetranychus* (*Eutetranychus*) *banksi* Banks, 1917, 3. *Tetranychus rusti* McGregor. 1917, 4. *Anychus rusti* McGregor, 1919, 5. *Anychus? latus* Hirst, 1923, 6. *Anychus africanus* Tucker, 1926, 7. *Anychus clarki* McGregor, 1935, 8. *Anychus orientalis* (Zacher) Klein, 1936, 9. *Anychus verganii* Blanchard, 1940, 10. *Anychus ricini* Rahman and Sapra, 1940, 11. *Eutetranychus claski* McGregor, 1950, 12. *Eutetranychus mexicanus* McGregor, 1950.

二、分　　佈

除新近在臺灣發現外，在美國的德克薩斯州 (Texas)，佛羅里達州 (Florida)，阿根廷 (Argentine)，墨西哥，(Mexico)，中南非洲之秘魯 (Peru)，義大利 (Italy)，巴勒斯丁 (Palestine)，埃及 (Egypt)，南非洲 (South Africa) 及印度 (India) 均有其分佈。

三、生　活　史

據十一月份之調查，其卵期為 6-8天，第一齡幼蟲期3-6天，第二齡若蟲期 4-6天，第三齡若蟲期5-7天，自卵至成蟲總計為18-26天，平均約為23天，成蟲壽命20-31天，雌蟲每天產卵1-4枚，每一雌蟲一生可產卵30-40枚，然產卵期有間歇性，發生於秋冬及早春季節。

四、各期形態（圖示）

(一)卵：形似鐵餅，扁圓形，直徑約 0.15mm，高約 0.06mm，初產之卵呈暗灰色，後隨胚胎之發育，色澤即起變化，首先部分變為橘黃色，以後橘黃色之胚胎漸膨大，終至全卵均為橘黃色，至孵化之前期，其幼蟲胚胎淸晰可見。通常在卵之邊緣，附着數條細絲，具穩固之作用。

(二)幼蟲：初孵化之幼蟲，自其側面觀之，成半圓形（即體背隆起，兩側較狹而扁），體長約0.20mm，呈橘黃色，體背之毛較細長（成棍棒狀，上具極細小之針狀刺），足三對，行動甚緩慢，至幼蟲之末期，幼蟲體漸成半球形。

(三)第二齡若蟲：幼蟲脫皮後便成為 8 足之若蟲，體長約 0.25mm，體色黃褐，體形成半球形。

(四)第三齡若蟲：形態與前者相似，體長約 0.30mm，體色為褐色。

(五)成蟲：雌蟲體長約 0.40mm，呈深褐略帶墨綠色，體成卵圓形，體背具十四對棍棒狀上着生刺毛之粗毛（在體背中部者較兩側者為短），體表皮具溝狀條紋。雄蟲體長約 0.30mm，色呈橘紅

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* 本文為 64—A—1643 計劃報告之 3，由計劃主持人陶家駒指導。

，足較雌蟲者爲長，體成盾狀，體背亦具十四對棍棒狀毛。

五、爲害狀與習性

由於其各期蟲體均不活潑，多固着於一處爲害葉片，故經其爲害之葉片，其斑點並不多，然較柑橘紅蜘蛛所爲害者爲大，斑點呈灰褐色，而其卵常產於陷入之斑點內，或葉表之中脈兩旁之夾縫間，其棲息多爲老葉之表面，尤其在中脈之兩旁爲其最佳之棲息處所，然在葉表面兩旁近邊緣處，也常有其羣體棲息，往往在同一處可見其各期之蟲體。雌蟲未脫皮羽化前，雄蟲即伏息其旁，一旦雌蟲羽化，即刻與之交尾，交尾之後，並不立刻產卵，需取食數日後方行產卵。

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THE NEW CITRUS PEST IN TAIWAN——TEXAS CITRUS MITE (*EUTETRANYCHUS BANKSI* (MCGREGOR))

By

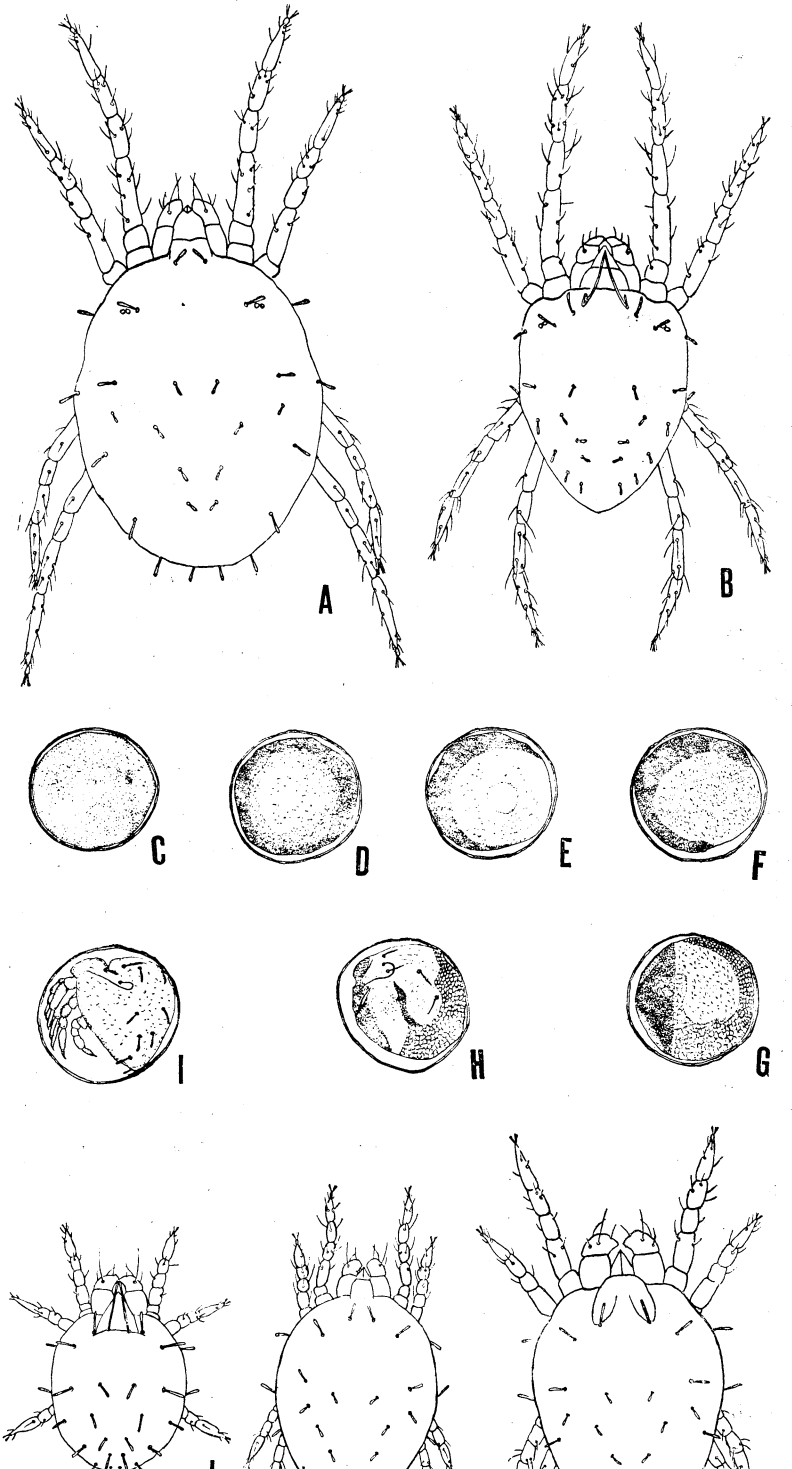
Paul K. C. Lo

SUMMARY

Texas citrus mite *Eutetranychus banksi* (McGregor) was first found in Taiwan 1964, regarded as the pest of citrus. Its life cycle was 18-26 days in November. It may be identified by a tan to green body coloration marked on the back with several pairs of dark green to black spots. The body hairs of this species are short. Eggs are flattened and disc-like with a yellow, brown or pink coloration. Young mites are like the adults except for size. Newlyhatched mites are six-legged and lemon-yellow in color.

Infestations of and injury to citrus by this mite are however, twigs have not been found to be infested.

Heaviest infestation of this mite has been found to occur in fall, winter and early spring.



圖：柑　橘　褐　蜘　蛛

A. 雌性成蟲，　B. 雄性成蟲，　C.—I. 卵期1～7天表示其胚胎之變化，
J. 第一齡幼蟲，　K. 第二齡若蟲，　L. 第三齡若蟲

SEASONAL OCCURRENCE OF ERIOPHYID MITES ON ELM TREE IN SAPPORO (JAPAN)*

by

TSAN HUANG**

It is well known that populations of mites are easy to vary as an adaptation to period and respondence to environmental changes. The purpose of this paper is to present a simple population data as a preliminary report on elm mites. Survey was conducted every day from Sept. 1 to Oct. 31 in 1964.

MATERIALS AND METHODS

Elm leaves injured by Eriophyid mites were sampled at random from plots A-a (represents an elm tree in front of Faculty of Agriculture, Hokkaido Univ.), A-b (represents an elm tree at the back of Faculty of Agriculture, Hokkaido Univ.) and S (represents an elm tree near Faculty of Science, Hokkaido Univ.) for an investigation of seasonal occurrence. At S plot, 15 elm leaves were collected at 10 a. m. every day. At the same time a thermo-hygrometer was hung on the trunk (kept one meter height from the ground) to determine temperature and the humidity. Both of A-a and A-b plots were arranged for an observation of populational fluctuation at 5 parts (viz., east, west, south, north and central). According to the height where leaves grown out, A-a plot was also divided in 3 portions (viz., high, middle and low) for investigating the population respectively. 6 leaves from each part were sampled every time. The circumstances of A-a plot and A-b plot were very different. The former stood in a wide place was without any interruption from sunlight and wind; whereas the latter, surrounded and prevented by large trees, was kept in the shade. The leaves collected, were brought into laboratory and put in a glass bottle with alcohol-sugar solution. A week later, the leaves were cast away and remained solutions were centrifuged. From which, 2 cc. (from the bottom of conical tube) were reserved and determined by examining under stereoscopic microscope. Species and numbers of Eriophyid mites were recorded. Mites numbers were calculated in per cm^2 and compared among 5 species.

RESULTS AND DISCUSSION

Eriophyid mites on elm tree from plots A-a, A-b and S, totalized in (1) every 10 days, (2) 3 different height of elm tree and (3) 5 parts (from direction), are presented graphically in Figures 6-10, which gave out the following results.

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* Conducted in Sapporo, Japan, in 1964.

** Chief, Department of Plant Protection, Fengshan Tropical Horticultural Experiment Station, TARI.

1. *Eriophyes campestricola* (v. Frauenf.) Liro; The maxima were, 1.6 mites/cm^2 in middle September, 0.5 mite/m^2 in low position and 0.5 mite/cm^2 in central part. The minima were, 0.1 mite/cm^2 in late October, 0.4 mite/cm^2 in both of high and middle positions, and 0.24 mite/cm^2 in north part.

2. *Eriophyes brevipunctatus* Nal.; The maxima were, 1.3 mites/cm^2 in middle September, 0.3 mite/cm^2 in both of low and high positions, and 0.25 mite/cm^2 in east part. The minima were, 0.1 mite/cm^2 in late October, 0.2 mite/cm^2 in middle position and 0.1 mite/cm^2 in central part.

3. *Anthocoptes punctidorsa* K.; The maxima were, 1.3 mites/cm^2 in middle September, 1.1 mites/cm^2 in low position and 0.83 mite/cm^2 in east part. The minima were, 0.2 mite/cm^2 in late October, 0.8 mite/cm^2 in both of high and middle positions, and 0.5 mite/cm^2 in central part.

4. *Oxypleurites ulmi* F.; The maxima were, 0.9 mite/cm^2 in late September, 0.5 mite/cm^2 in low position and 0.4 mite/cm^2 in central part. The minima were, 0.1 mite/cm^2 in late October, 0.4 mite/cm^2 in both of high and middle positions, and 0.25 mite/cm^2 in south part.

5. *Rhyncaphytoptus ulmivagrans* K.; The maxima were, 1.6 mites/cm^2 in middle September, 1.3 mites/cm^2 in low position and 2.03 mites/cm^2 in north part. The minima were, 0.1 mite/cm^2 in late October, 0.6 mite/cm^2 in middle position and 0.82 mite/cm^2 in central part.

The weather in 1964 was colder than ordinary years and severely influenced an appearance of mites. Eriophyid mites on undersurfaces of elm leaves came into view under stereoscopic microscope on the time near the end of August. But defoliation of elm tree came to the end in late October. So that sampling work was continued only two months (from Sept. 1 to Oct. 31).

On the whole, rise or decline of the graphs followed a remarkably similar pattern among 5 species of Eriophyid mites on elm. The charts show that each species similarly has the maximum population in middle September (Fig. 6) and in low position of the tree (Fig. 7). In comparison among 5 parts (viz., east, west, south, north and central), the maximum population was given from north part in September and from west part in Octobar (Figs. 8 and 9).

It was considered that high temperature and the lowest humidity in middle September enabled the mites to reach the high peak of their population (Fig. 6). Nevertheless no reasonable explanation was accepted for the mites numerous at north part in September and west part in October. This was remained as a pending problem and put in expection of later study.

ACKNOWLEDGEMENTS

The writer is much obliged to Prof. Dr. M. Yamada and Dr. S. Ehara for thier pertinent instructions and kindful suggestions. Sincere appreciations are also extended to Prof. S. C. Chang for his kindful criticisms of the manuscript.

Fig. 1. A view of A-a plot.

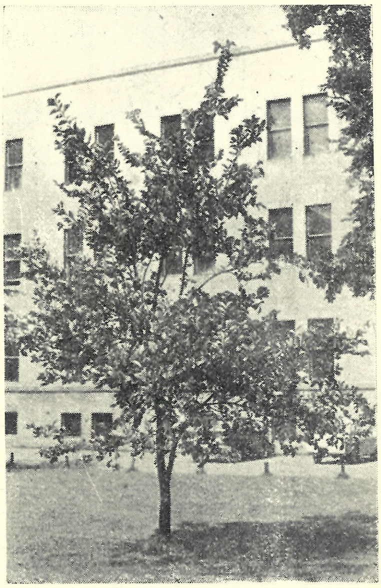

Fig. 2. do., more close.

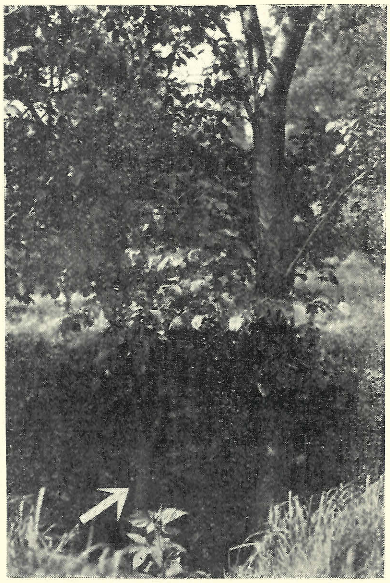

Fig. 3. A close view of A-b plot.

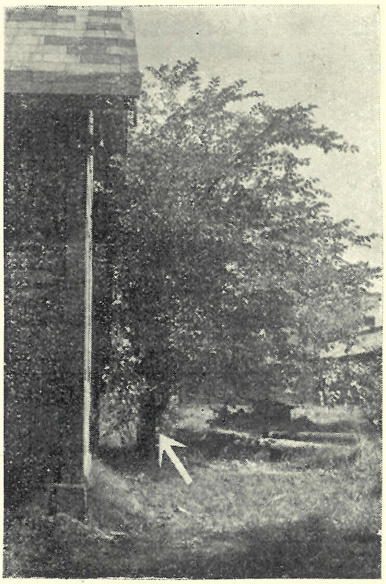

Fig. 4. A view of S plot.

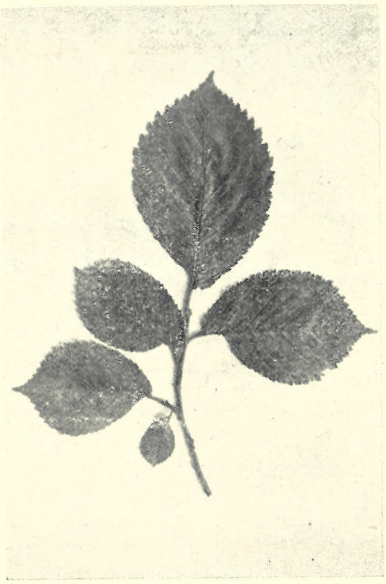

Fig. 5. Elm leaves, which undersurfaces were inhabited by a lot of Eriophyid mites.

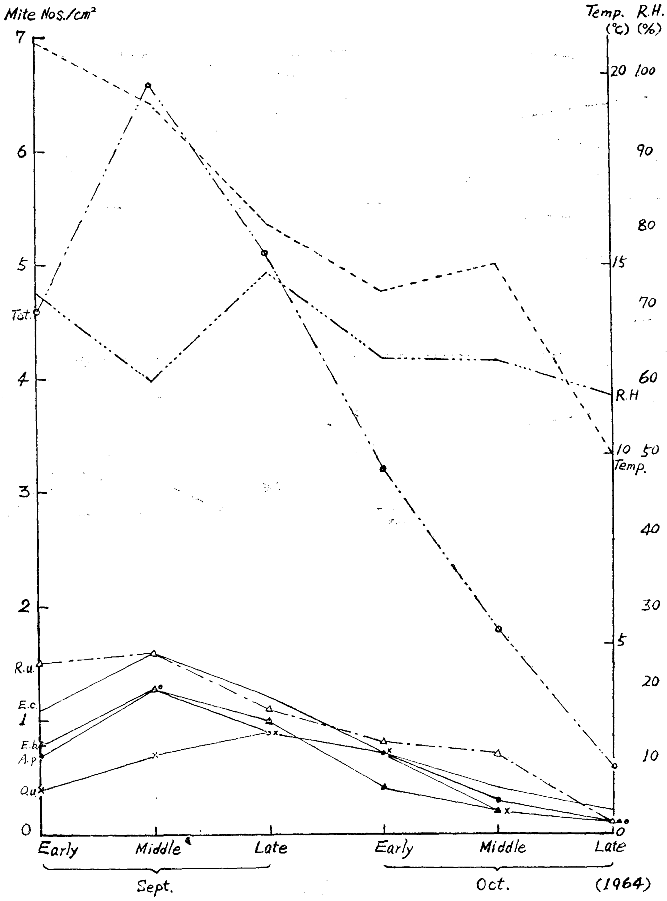

Fig. 6. Showing a variation of numbers of Eriophyid mites on elm, from plots A-a, A-b and S, totalized in every 10 days.

Explanatory Notes for Figs. 6-10.

(1) ———— for *Eriophyes campestricola* (v. Frauenf.) Liro.
(2) ▲————▲ for *Eriophyes brevipunctatus* Nal.
(3) ●————● for *Anthocoptes punctidorsa* Keifer.
(4) ×————× for *Oxypleurites ulmi* Farkas.
(5) △-·-·-·-△ for *Rhyncaphytoptus ulmivagrans* Keifer.
(6) ○-·-·-·-○ for total numbers of the mites.
(7) —····—····— for % of relative humidity.
(8) ·················· for °C of temperature.
(9) —···—···— for total nos. of the mites in average in Sept.-Oct., '64.
(10) ——·····—·····— for total nos. of the mites in Sept., '64.
(11) ——·······——·······—— for total nos. of the mites in Oct., '64.

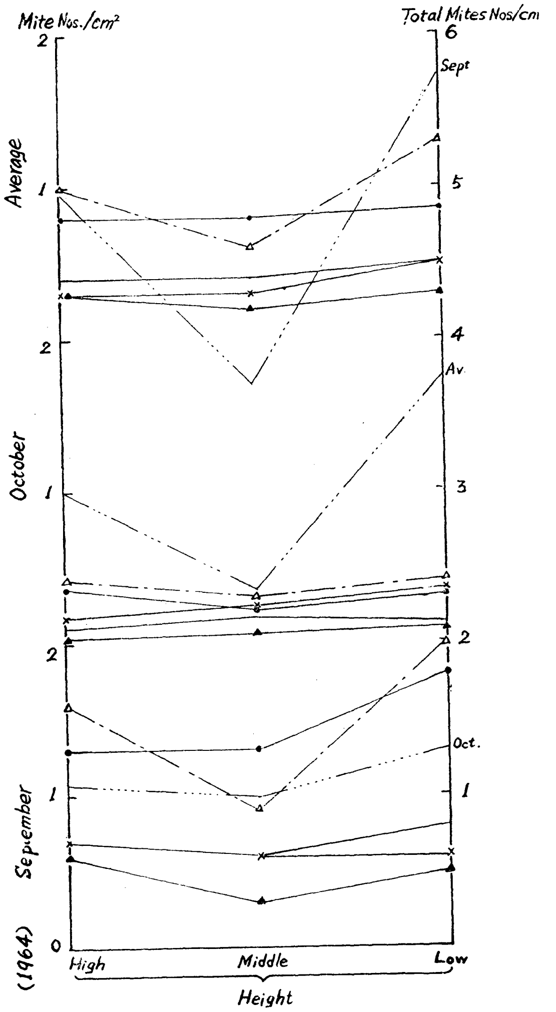

Fig. 7. Showing a variation of numbers of Eriophyid mites, from A-a plot, totalized in 3 different height of the tree.

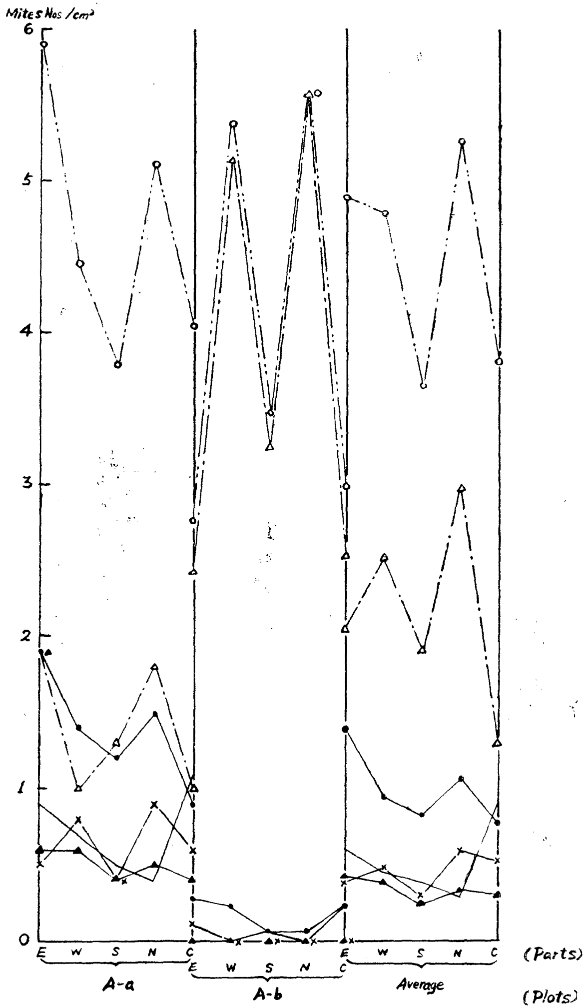

Fig. 8. Showing a variation of numbers of Eriophyid mites, from plots A-a and A-b, collected in Sept. 1964, totalized in 5 parts.

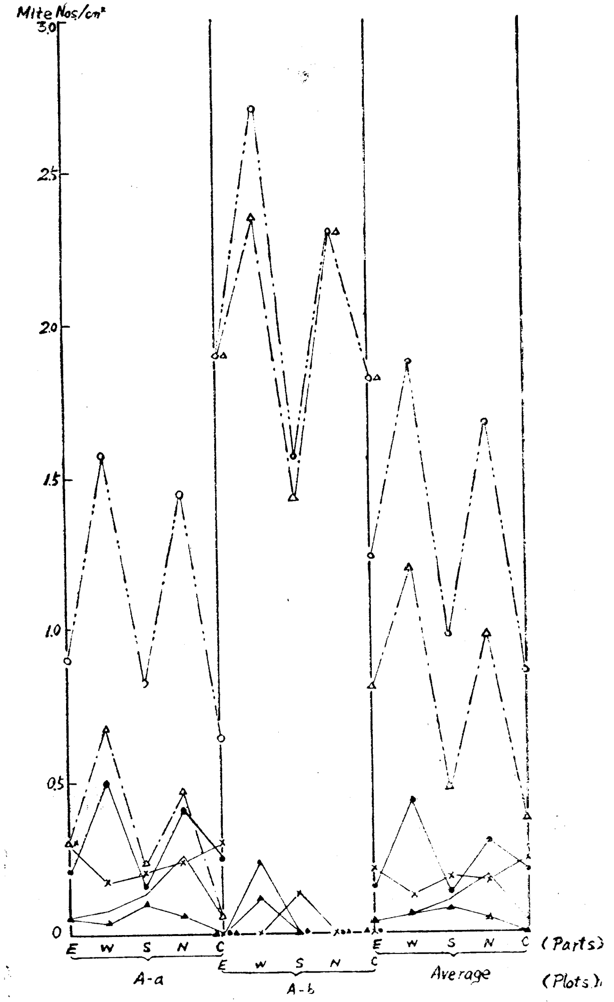

Fig. 9. do., collected in Oct. 1964.

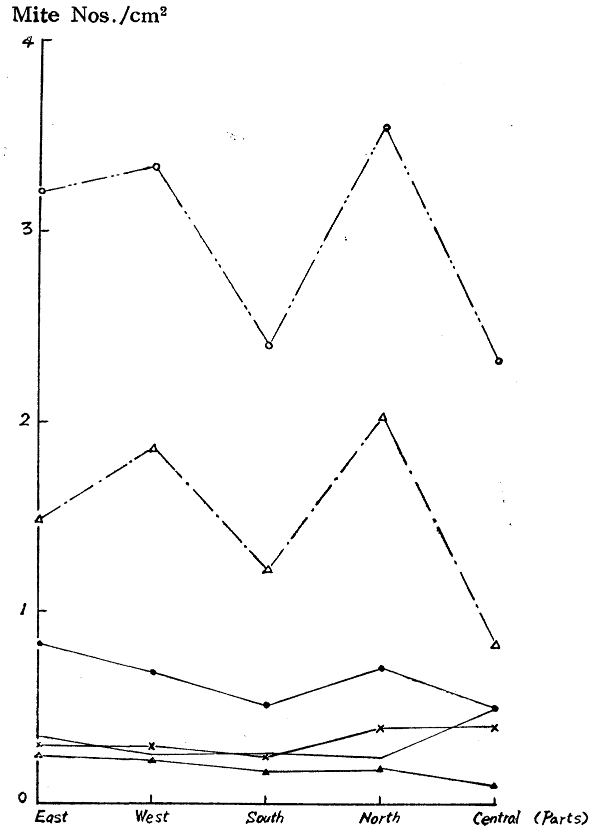

Fig. 10. Analytical data from figs. 8 and 9. The mites are retotalized in combination with Sept. and Oct.

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札幌(日本北海道)楡樹 Eriophyid Mites 之發生情形

黃　　讚

摘　　要

本文係就日本北海道大學（位於日本北海道札幌市）理學部及農學部附近之楡樹 Eriophyid Mites，調查其發生情形所得之結果。

文中所列述之楡樹 Eriophyid Mites 包括有下面之 5 種。

1. *Eriophyes campestricola* (v. Frauenf.) Liro
2. *Eriophyes brevipunctatus* Nalepa
3. *Anthocoptes punctidorsa* Keifer
4. *Oxypleurites ulmi* Farkas
5. *Rhyncaphytoptus ulmivagrans* Keifer

根據所得結果，最高蟲數發生於溫度極高而濕度最低之 9 月中旬。

文 獻 介 紹

ABSTRACTS OF LITERATURE

一. 纖維之王——棉 [Vernon L.Harness (1964) U.S.D.A Year Book 220～226]

棉花之利用歷史至少已達五千年之久。目前與棉花相競爭之纖維雖有很多種類，但棉花對人類之貢獻仍日趨重要，更甚於往昔。

陸地棉、海島棉之染色體爲26對，乃四倍體。亞洲棉種類之染色體計13對，乃二倍體。

美國植棉面積，佔棉花地帶 (Cotton Belt) 可耕面積三分之一；1958～1962年之五年平均，年產 13,900,000 包皮棉。而全世界之棉產量，1963年計達 49,600,000 包皮棉。目前產棉國家已達75個之多。最重要產棉區如下：美、俄、中國大陸、印、墨、巴西、埃、巴基斯坦、土、蘇丹、敘、秘等是也。

陸地棉與埃及棉二種類，佔世界棉產八分之七；而亞洲棉種類 (Asiatic Cotton) 僅佔八分之一，亞洲棉種類之產額約爲皮棉 4,000,000包，大部份產於印度及中國大陸。

棉田工作大部消耗於除草，故近年除草劑之施用日趨興盛。除蟲農藥亦爲棉農之得力武器。

棉纖維之物理性如長度、强度、細度、成熟度之決定因素爲品種、氣候、及栽培方法。至於纖維色澤、葉屑、及軋工精粗，則大部份受氣候之影響。

美國出口棉花之最大主顧爲日本，約佔美國出口棉產三分之一。美國出口棉花之其他主顧爲法、德、義、英、香港、中華民國、菲律賓等地。（孫貽謀）

二. 紫雲英種子硬粒問題之研究 [Isao Suetsugu (1960) 北陸農業試驗場報告 No. 1, 89～121]

紫雲英種子多硬粒，正如其他荳科作物相同，乃栽培上重要問題。硬粒性之原因未獲充分明瞭，乃紫雲英育種之基本研究一端，因而作本問題研究如下：

(1)紫雲英種子之吸水部分

紫雲英種子經由種臍周圍之種瘤 (Strophiole) 吸水，經證實如下：

紫雲英之軟粒種子在未浸水前，若用石臘在種瘤外封住，則此軟粒種子不能吸水膨大。

種瘤較其他種皮部份有較厚之柵狀層，並且缺乏表皮細胞，種瘤中部之柵狀細胞無單寧質，不同於其他部分。

(2)硬粒性之轉變

種子成熟後，種子體積收縮完畢。此時種瘤乃不透水性（透明、硬粒）。在夏季期間保留不透水狀態，至秋季多數種子轉變爲透水性。以後冬季，少見硬粒性變化之存在。

(3)硬粒與非硬粒之差異

種子外部形態上顯著不同之點，在吸水部位種瘤之透明度 (Transparency) 有異。硬粒性者一律透明，而非硬粒性者除中央部外白色不透明。由作者實驗結果，凡有透明種瘤者是硬粒種子，而不透明者乃軟粒種子。

(4)品種與硬粒性

用花期早遲不同之10個品種（會津、福地、山形１號、中野小屋、宮古木、富農選24號、歧阜紀念大晚生、歧阜組合大晚生、高知在來、小山等10品種），每品種 3～10 單株。在二項實驗中結果如下：

開花期早晚不同之品種，其種子軟化之步調不同，一般在寒地則晚熟種之軟化較遲，而暖地則早熟種之軟化較遲。兩者適相反，此種差異，主要的是秋季變溫時乾燥度不同所致。同樣情形，徐慶鐘氏發現在臺灣之黃麻硬粒種子因乾燥而增；而極度乾燥時，硬粒種子却又減少。

總之，種子軟化之不同，受到成熟期氣候，採種方法等影響而異。

此外，早熟與晚熟品種在開花期之營養生長不同，關係於種子充實度之結果，間接影響種子之硬粒性亦所不免。

(5)硬粒性之遺傳

由粒形之不同可以看出硬粒性之差異，今在遺傳學上已知粒形乃遺傳形質。因此與粒形有關之硬粒性（硬粒性程度之强弱）亦均爲遺傳性狀。

(6)硬粒性之人爲控制

若將乾燥成熟種子貯藏於低恒溫下，能使種子保持硬粒性。若欲使種子軟化亦有數法，即劃破種皮、變溫、及硫酸處理。

(7)荳科作物種子硬粒性之分類

種子吸水型式，依植物之種或屬而不同。因此，軟化種子之條件亦不相同。荳科植物之種屬間硬粒性可依吸水部分之性狀而分之。（孫貽謀）

三. 倍數性西瓜種子形態之比較研究 [下間實，松本賢三（1957）生研時報 8, 67～74]

據云市販之 3x 西瓜種子中，常因撰別工作缺佳而混合着一些 4x 或 2x 西瓜種子。雖然倍數體西瓜種子與普通西瓜種子可藉其大小，種皮有無裂紋等而鑑別，爲求提高撰別工作之精密起見，著者等深入研究 2x ，3x 及 4x 西瓜種子間之形態變異之程度。

3x 西瓜品種間之種子形態比較研究使用 (1) 4x 富民×2x 旭，(2) 4x 旭×2x 富研（固定），(3) 4x 富民×2x 都3號。爲與(2)比較起見，除上記三品種外，使用 4x 旭與 2x 富研（固定）。供試種子數各品種均爲500粒。就種子之縱徑、横徑、厚度及重量等四項目調查結果，各 3x 品種間之變異曲線概有一致之趨向。至於 2x，3x，及4x 種子間之變異如下表。

項目 \ 品種	2x 旭	3x（旭×富研）	4x 富研
縱徑 (mm)	7.9±0.40	8.3±0.36	7.9±0.61
横徑 (mm)	5.1±0.25	6.0±0.30	6.0±0.23
厚度 (mm)	1.9±0.13	2.2±0.15	2.8±0.25
重量 (mg)	41.5±4.95	59.9±6.05	68.5±6.25

供試 3x 種子雖然經過形態上之識別認爲 3x，但爲愼重起見任意撰出各品種 500粒之種子以供檢定根端細胞染色體數之用。即在 4x 旭×2x 富研，確實算到染色體數目的188個體中，2 個體爲 4x，其餘爲 3x。在4x 富民×2x 旭，136個體中，1 個體爲 4x，其餘爲 3x。

在另外一個調査，將市販之 8 品種 3x 品種依形態上之特徵而分爲 A（認爲 3x 者）及 B（認爲 3x 以外者）兩組，併檢定其染色體數。供試 8 品種之 A組均無 3x 以外者發現，但在 4x 旭×2x 三笠之 B 組，被檢個體數30中，曾發現之 2x，3x，4x 及異數體各佔 1，21，5，3 個體；4x 富民×2x 旭之被檢個體 9 中，3x，4x 各佔 5，4 個體；無籽富研被檢個體數 34 中，2x，3x 及4x 個體各佔 3，29，2。由此研究可知市販 3x 西瓜種子中含有不少 3x 以外之種子，但依照形態特徵撰別認爲 3x 者全是 3x，此即表示，雖在自然放任情形下採種，然後應用形態特徵撰別，亦可照樣得到純粹之 3x 種子，按自然放任採種遠較套袋授粉法可節省勞力及費用。（洪祖仁）

四. 洋菇之混合播種法 [C. Riber Rasmussen (1959) Mushroom Sci. IV, 21～29]

以往洋菇栽培所慣用之播種方法均以點播爲主，並且播種後在安靜狀態下使其菌絲伸展，本文提供了一種新方法稱爲混合播種法：即播種後菌絲伸展到點播穴距之一半時將床上之堆肥把動使菌絲與堆肥充分混合使其接觸全床堆肥之深淺任何部位，如此處理雖看不到白色之菌絲但已經使菌絲與菌絲間之距離拉近，改善菌絲與堆肥之平衡性，可以合理的利用菌床材料可提高單位面積之產量。使用本播種法之洋菇在87天中每一平方公尺產量可達到 31.6公斤若叩除15%之菇脚尚有24公斤多，本方法菇床之厚度可加强到27公分產量最高，（使用一般播種法時菌床厚度以18公分時產量最高）若使用混合播種法而菌床厚度仍然是18公分時，同樣在87天中每一平方公尺之產量仍有20公斤，換算成本省慣用之坪時每坪仍有66公斤，比本省之平均產量13公斤時將近有五倍之多，唯

本方法之播種量要比一般之播種法要多一倍左右，在經濟上言之仍是可行之方法。

本文之未尾附有德文及法文摘要並提供參考文獻九本。（杜自疆）

五. 洋菇菌床之毛細管灌水法 [P. B. Flegg, (1962) Mushroom Sci. V, 384～389]

洋菇之灌水技術一向是洋菇菌床管理上之難題，就因爲手工撒水在水量及給水時間無一定之指示物供爲參考，故在菌床濕度之保持與用水之經濟方面仍遺留很多問題。本文對洋菇菌床之灌水方式提供了新的觀念，本方法由於英國溫室作物研究所設計應用到洋菇菌床上來，此種裝置稱爲毛細管灌水系統。

其原理是應用油燈之燈心能利用毛細管作用把油吸到比油面高的地方，利用此種能力把水吸到洋菇菌床而已。本試驗進行時曾經試用過很多種材料，其結果得知以寬一英吋長十八英吋之人造絲或者毛氈之長條對寬 2 英呎，長 3 英呎之木箱其燈心作用最爲良好。

毛細管灌水法有節省人工，灌水量適當的自動控制，防治床土之過乾與過濕，因之產量亦略有提高，現以每平方英呎之產量（磅）比較時，採收四星期之總產量普通法是 1.61磅，毛細管法則 1.91磅，再以八星期之總產量比較時普通法爲 2.30磅，毛細管法却在 2.69磅，均比普通手工法略有提高，故可說是極有實用價值之方法。

本文中有設計圖二張，說明照片二張，參考文獻二編，另附有英文、德文、法文摘要。（杜自疆）

六. 洋菇菌絲束之伸展與子實體形成之關係 [P. B. Flegg (1962) Mushroom Sci. V, 300～313]

關於洋菇菌絲伸展能力之强弱與洋菇子實體之產量：以往常有正相關之誤解觀念。英國溫室作物研究所關於此問題作了以下的報告。

洋菇菌絲束在堆肥蓋有土壤之菌床上伸展迅速而健全，並不一定與洋菇子實體之形成有正相關，本文又說洋菇菌絲之伸展能力之强弱，直接受到堆肥含水量之影響，在堆肥含水較多時伸展迅速，堆肥較乾時伸展較緩慢，但其含水量以堆肥能通氣之程度爲界限，若含水量達到洋菇菌絲窒息時當然生長不良。此外尙略受到堆肥培養基中含鹽量之影響，在洋菇之全生活期中對鹽最敏感之時期是從下種到形成小幼菇；其直徑在 1cm以下之期間，每箱之覆土中使用 4～8g 鹽能使洋菇菌絲伸展良好。

本文中有挿圖二張，說明照片十四張，引用文獻十六編。（杜自疆）

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